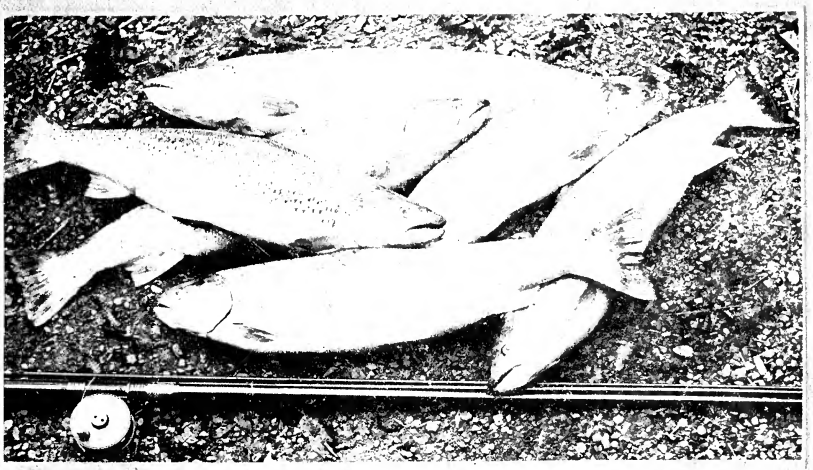

LIFE HISTORY AND HABITS OF THE SALMON SEA-TROUT AND OTHER FRESHWATER FISH

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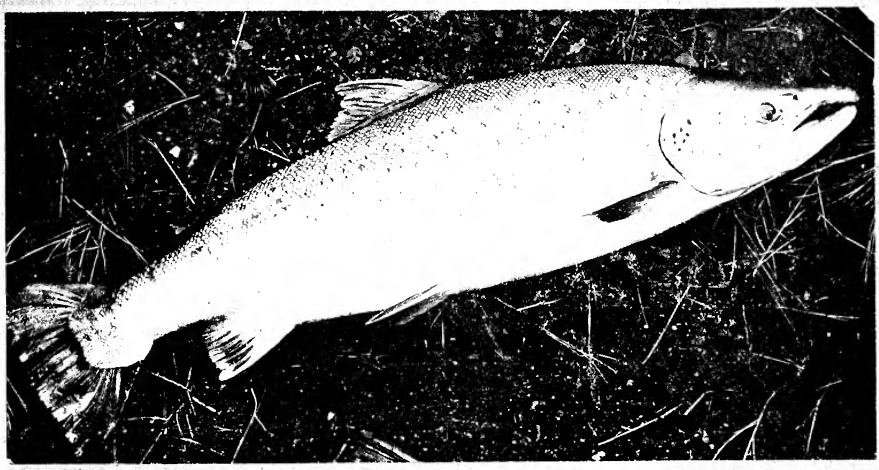

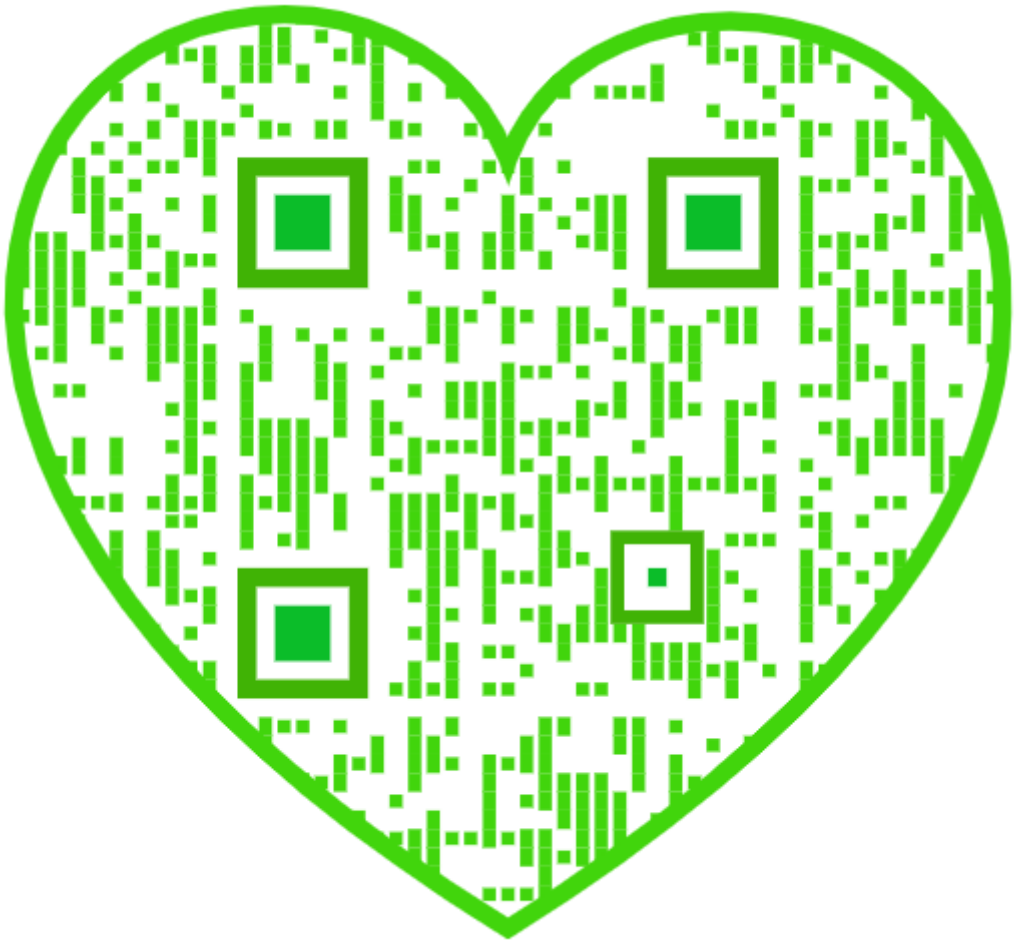

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LIFE-HISTORY AND HABITS OF THE SALMON SEA-TROUT, TROUT, AND OTHER FRESHWATER FISH

BY

P. D. MALLOCH

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1912

First Edition, published January 1910.
Second Edition, published May 1912.

PREFACE TO SECOND EDITION

WHEN I published the first edition of this work, less than two years ago, little did I think the publishers would call upon me to issue a second within so short a period. It is most gratifying, indeed, to me to know that my endeavours to give reliable information about the "Life-History of the Salmon" have been so well received. The press notices and the private letters I have received from all parts of the world have greatly cheered and encouraged me in this work, and I take this opportunity of thanking all for their favourable comments. During last year I devoted what spare time I had to the study of scales from fish which had returned a second time from the sea, the results of which are embodied in this edition.

There are thirty-five new illustrations added.

P. D. MALLOCH.

PERTH, *January* 1912.

PREFACE TO FIRST EDITION

Fish and their ways have at all times engaged the attention of the writer, and the outcome of these studies has been the production of this volume. Within its pages he has endeavoured to clear up many points relative to the history of salmon and trout which have until lately remained a mystery. So many unsatisfactory theories have been advanced, that he determined to take full advantage of his position as Manager of the Tay Salmon Fisheries Co., Ltd., and do all in his power to investigate and further our knowledge regarding this most interesting branch of Natural History. With this end in view, the marking of smolts on their way to the sea, and their recapture afterwards, have been extensively carried on, and their weight, date of capture, and the particular run to which they belonged, have been carefully recorded.

Hitherto it was believed that salmon smolts returned as grilse the same year as they went down to the sea, but a study of the smolt does not bear this out. Again, the writer shows that the large Spring salmon, the small Spring salmon, and also the "Summer Run," are on their first return from the sea, and not from the kelt grilse as many supposed. Evidence is also given that the so-called salmon bull-trout is not a trout, but a true salmon which has spawned, and consequently has become altered in appearance and white in the flesh. From a study of the scales the age of a fish can be arrived

at, and with the help of the numerous illustrations the reader will be able to refer any fish to the particular run to which it belongs, to ascertain its weight and age, and how often it has returned to fresh water. Although about sixty illustrations of scales are given, thousands had to be collected at all seasons and examined carefully, so that a definite conclusion could be arrived at. The illustrations are from photographs which, with one or two exceptions, were taken by the author from selected specimens.

To Mr. Charles Baker, High Holborn, London, he is indebted for enlarging the photographs of the scales; to the Swantype Co., for the blocks from which the illustrations are taken; and to the printers, Messrs. R. & R. Clark, who have carried out the work to his entire satisfaction.

P. D. MALLOCH.

PERTH, *December* 1909.

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THE SALMON

(*Salmo salar*)

THERE are so many mysteries connected with the life-history of the salmon that it is impossible for any one individual to solve them all; but as they have been the object of my closest study for over thirty years, I trust that what I have to say may help to elucidate some of these problems.

The ova are deposited in the gravel by the female salmon during the autumn, the male fish covers them with milt, and the time required for hatching is from seventy to one hundred and twenty days, according to the temperature of the water. On emerging from the eggs the young soon begin to show signs of life, and wriggle energetically through the gravel to reach the surface. At this stage they are called "alevins," and hardly yet have the appearance of fish, for attached to their bodies, a little behind the gill-opening, is a large bag, the yolk- or umbilical- sac, containing enough nutriment to sustain them for several weeks. Before, however, this is entirely absorbed, they begin to search for natural food and push energetically up-stream. In a short time, after having assumed the true fish shape,

FIG. 1.—Alevins.

they collect in shoals and are called fry. By autumn they are from two to three inches long, and are then called parr (Fig. 2). Very little feeding takes place after the end of September, and when the cold weather sets in, the parr leave the shallow water to take up their abode under stones, where they remain till March or April, and almost entirely cease to feed. During their stay in winter-quarters they become very black and fall off in condition. Often, when collecting larvæ, I have lifted a flat stone quietly and disclosed to view three or four parr. These did not swim away at first, but remained motionless for some time, apparently in a dazed, sleepy condition. When the water

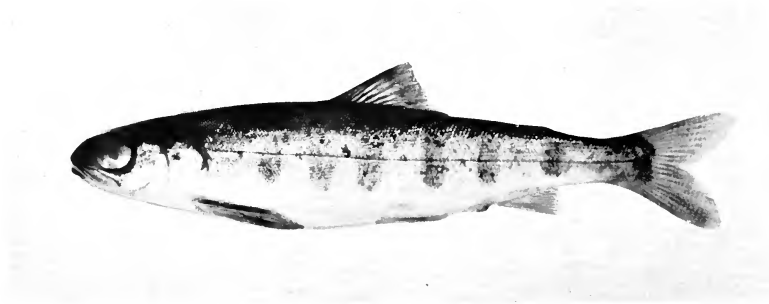


FIG. 2.—Parr, life size, one year old. 1st April 1903.

becomes warmer their winter abode is forsaken for the quieter pools. Strange to say, they are now smaller than they were during the autumn. As the season advances they become lively, frequent shallow water, forsake large rivers, and run up the smaller streams as far as the water will take them. They increase quickly in size, and by autumn are double the dimensions they were in the previous autumn. The parr is now a very handsome fish indeed. Along its silvery sides are nine bars, with black and red spots, and the tail or caudal fin is much rounder than before. During winter, again, the parr retire to their old haunts, and leave them in March and begin to feed. About the first week in April a great change takes place in their appearance; the silvery smolt dress is assumed, and the dawn of

a new era begins. They become covered with silvery scales, their tails lengthen and become forked, and their fins are enlarged. This

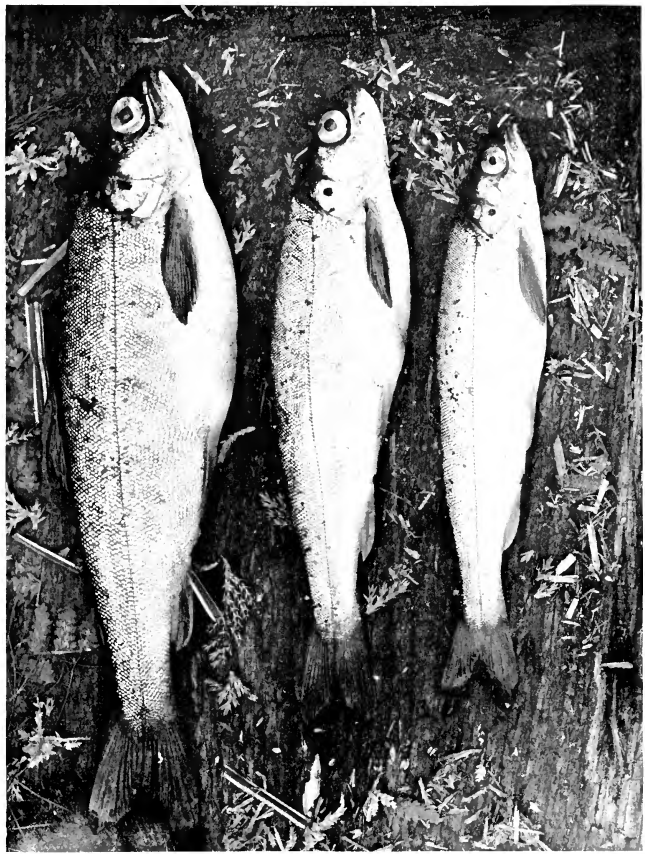


FIG. 3.—Salmon Parr, life size. River Dochart, September 1906.

change is quite a rapid one, the fish collecting in shoals during the process. As the season advances the true smolt stage is reached, and the migratory period begins. In large rivers the descent is made at any convenient time, but in small streams they can only descend during

small spates. Full advantage, however, is taken of every little freshet, and on arrival in tidal water they disappear into the sea. At the

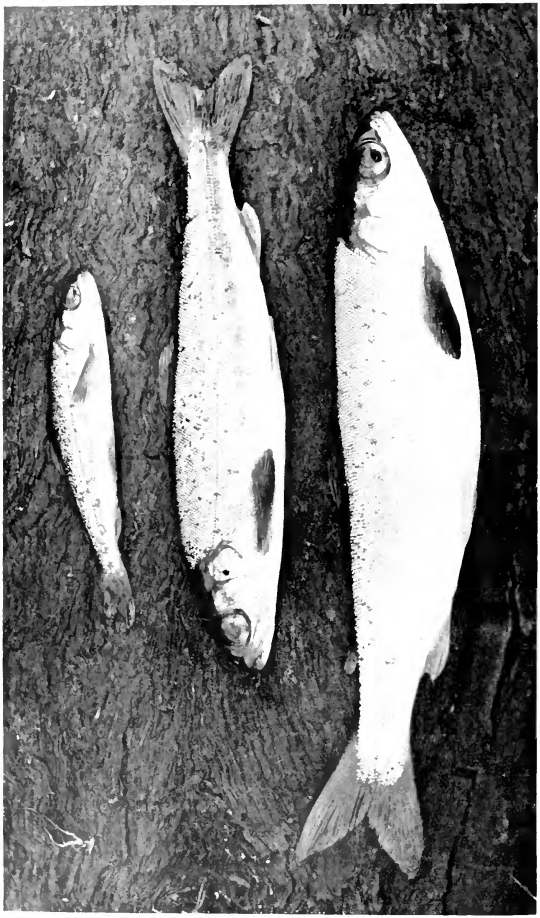


Fig. 4.—Life-size Parr, one year old. Parr, two years old. Smolt, two years. April 1905.

river-mouth many a feathered foe awaits their coming, Cormorants, Goosanders, Red-breasted Mergansers, Red-throated Divers, etc.,

causing great destruction. At the mouth of the river Grimersta in the island of Lewis, I have seen the Red-breasted Mergansers

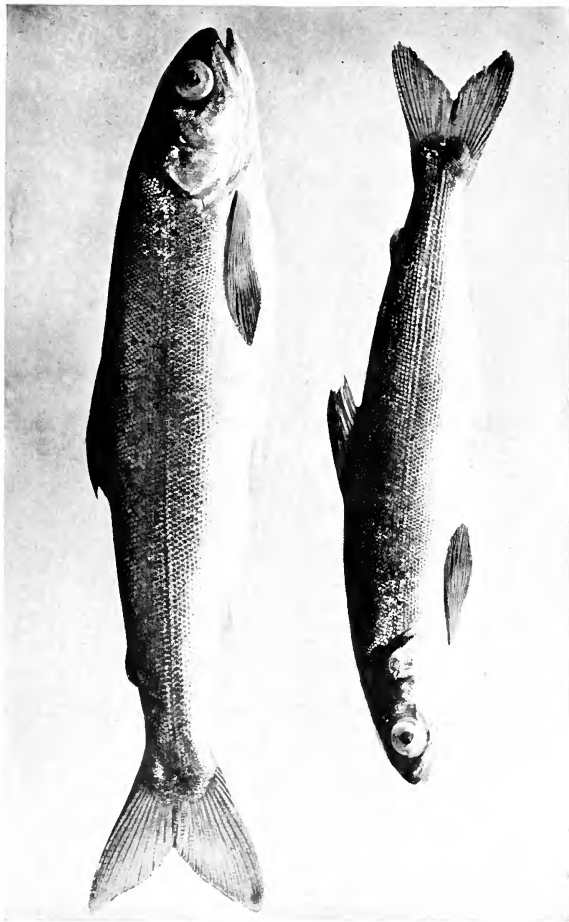


FIG. 5.—Real Smolts, life size, with their silvery coat complete, on their way to the sea. 1st May 1905.

coming and going all day long in a continual stream, feeding on the smolts as they entered the sea. I shot several returning from

their forays and found them to be full of smolts. As the smolts have so many enemies to evade, too little attention is paid to their protection. Our young grouse would fare badly if protected in a similarly scanty manner. In some rivers, trout-anglers are prohibited from fishing during the time of migration, but during the remainder of the season the parr are slaughtered in thousands. I am certain that in the Tay district at least one thousand parr and smolts per day, from April to September, find their way into the angler's basket. This is a gross total of about 157,000 for six months, and if four per cent found their way back as salmon, the gain would amount to 6280. Now this alone would be a good yield for many rivers; but if we take into consideration the ever-increasing number destroyed by birds, the victims of seals, coal-fish, pollution, etc., we find that the destruction and loss are appalling. Sooner or later those having the power to rectify this matter will waken up, and at no distant date our rivers will be teeming with salmon. The wheels of legislation

FIG. 6.—Life-size Smolt. 1st May 1905.

regarding the improvement of our fisheries revolve slowly, however, for year after year the Blue-books contain articles suggesting im-

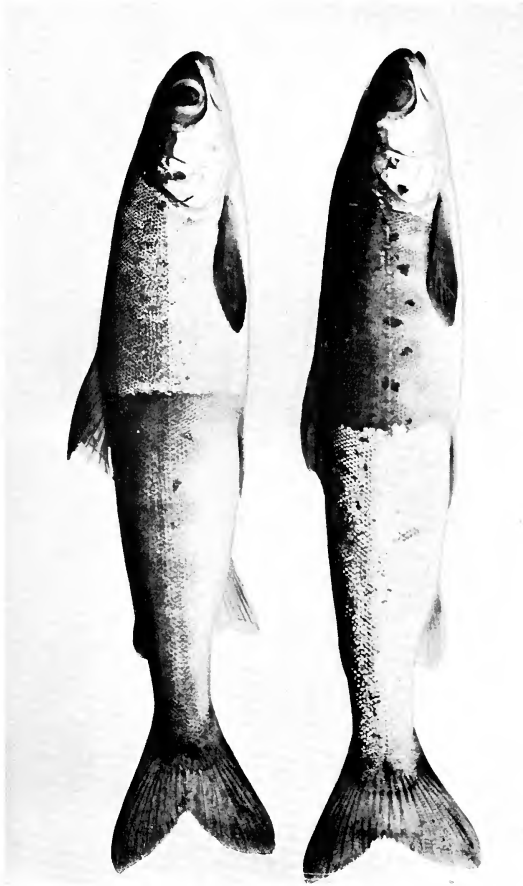


FIG. 7.—Smolts, life size, with the scales taken off, showing the parr bands and spots of the parr. 1st May 1905.

provement, but, like the hardy annual, these are forgotten till they reappear the next season.

I have wandered away from my subject, and now return to follow

the course of the smolts. This has, however, to a certain extent

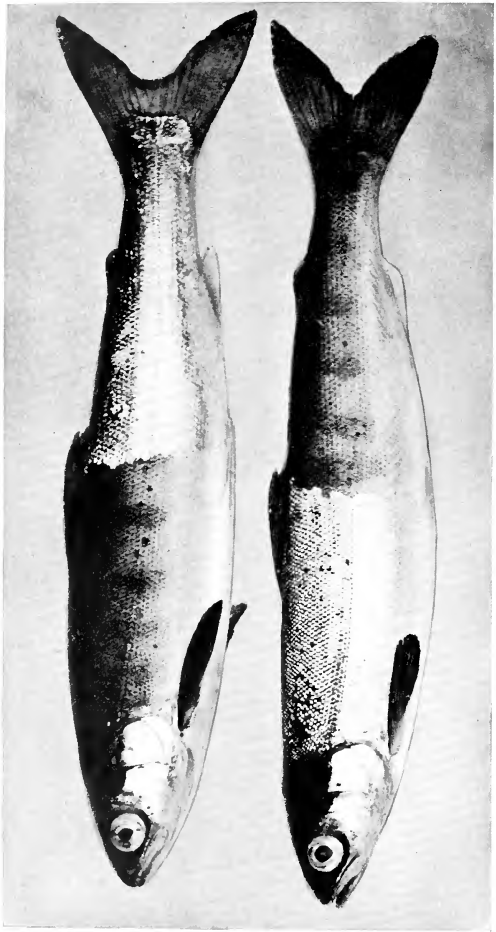


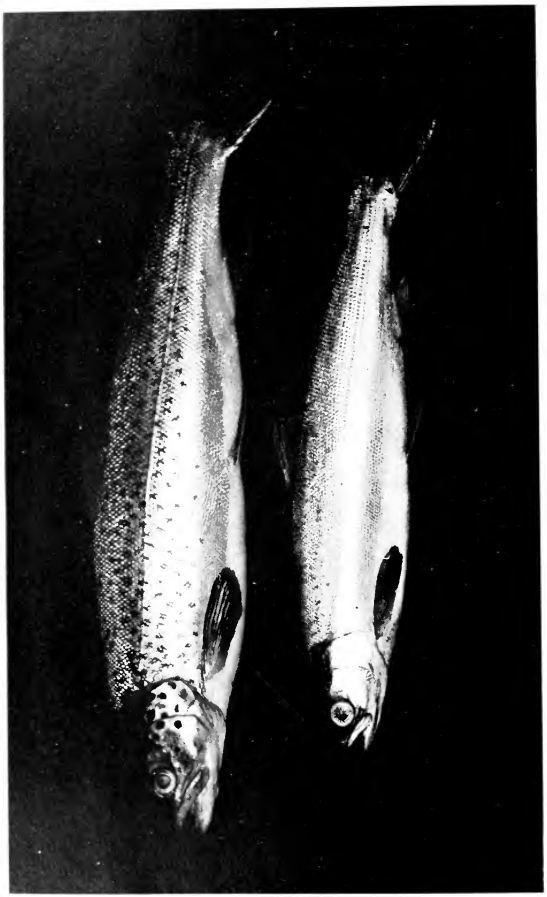
FIG. 8.—Smolts confined until 6th June, with the silver scales taken off, showing the parr bands below.

proved to be an impossible task, for when the smolts enter the sea all traces of them are lost for a while, and we know not where they have

(2) (1)

FIG. 9.—Life-size Parr (1) and Trout (2), showing the difference between the two.

gone. Our next acquaintance with them is on their return to the rivers as grilse and salmon. Smolts go down from the end of March



(1) (2)

FIG. 10.—Loch Leven Trout (1) and Salmon Smolt (2), both with their silvery coat. June 1906.

until the middle of June, and a few stray ones a little later. No autumn migration takes place. This has been proved on the Tay by

netting during the autumn and winter. About fourteen months after the smolts have migrated, a run of small grilse appears. The first usually arrive during the last week of May or the first week in June, and in the Tay weigh from 1½ to 2½ lbs., while in some rivers they are even smaller. Most of the northern rivers are much earlier than the Tay, and grilse make their appearance as early as the first week in April. As the season advances the weight of the grilse increases rapidly. This is due to its food being most plentiful in the summer months. At the end of June they weigh about 5 lbs., at the end of July 8 lbs., and at the end of August 10 lbs.—exceptionally large ones weighing from 10 to 12 lbs. In cold, backward seasons they are much smaller, and this applies to all rivers in Great Britain. The grilse distribute themselves over the whole river, and the run continues until the end of December. In the first week of November spawning commences. Many return to the sea soon after spawning, while others remain until April, and are very greatly reduced in weight, averaging from 2 to 7 lbs. Their sojourn in the sea varies from three and a half to eighteen months. During this interval a rapid increase in size takes place, and they return again as salmon, double their former weight. They first return about the middle of June (see scales of a grilse after its second return from the sea), and increase in number and weight until the end of December, their age at the latter date being four years and nine months. Others remain in the sea during the winter, and do not return until the next summer, having been away for one and a half years. Thus some spawn in each of two consecutive years, while others only spawn once in that time. Unless one has studied scales, it is difficult to distinguish between a kelt grilse of 4 lbs. and a kelt of a small spring fish of the same weight. This can easily be done, however, by counting the number of rings on the scales, or the number of contractions on the scales.

Hitherto it was thought that the small and the large spring salmon were from kelts of grilse of the previous year, but this is not the case. The small spring fish are of the same age as these grilse. They come up in the following spring, and are from 15 to 40 lbs. in

weight. This is their first return from the sea since migrating about three years previously as smolts, and they are therefore five years old. Very few, indeed, have spawned before. There is no difficulty in distinguishing between fish that have spawned before and those that have never spawned. The latter almost always have spots on the body near the gill-covers, and parasites are usually attached to their gills. I have now reached the end of the grilse stage.

Other smolts going down at the same date—April—as the ones the grilse come from, instead of returning as grilse begin to run about the middle of December, when the grilse have almost ceased. These are clean fish, and will not spawn till November, being thus nearly a year in fresh water before spawning. The first run of these fish in the Tay usually weigh about 6 lbs. each, and the weight continues to increase with every catch up to the middle of June, when a weight of from 11 to 13 lbs. is attained. By this time the run is completely over. From the results of our marking it will be seen that the earliest of these fish have been in the sea seventeen months from the time they went down as smolts, in April 1905; and the last, which were caught on the 14th of June, twenty-three and a half months. A very few may be later. I have paid particular attention to this run of fish for the last nine years, and I find that they disappear at the same time almost to a day every year. Many people hold the opinion that these fish are belated grilse, but I have always differed from them. These fish are similar to the small fish found in the North Esk, the South Esk, the Dee, the Findhorn, the Ness, the Beauly, the Brora, the Helmsdale, the Thurso, and many other rivers. Some years they are more plentiful than others: this year—1907—they were very plentiful. They run very fast and push far inland, are very strong, and able to surmount very high falls. Taking freely they afford splendid sport to the angler, while for the table they cannot be surpassed. In May and June few of them remain in the lower reaches. I have known them to run 30 miles in two days. Spawning commences about the middle of November, and being mostly in the higher reaches and in the smaller rivers, the fish fall back quickly afterwards. Besides what

we have mentioned, there is still another distinct run of fish of the same marking (April and May 1905), which comes on a month later (18th July 1907). From the marking it will be observed that the last marked fish, when caught on 14th June 1907, was 11 lbs. The next fish was caught on 18th July, and weighed 18½ lbs.; while the largest marked fish, got on 9th August, weighed 27 lbs. During the month of August marked fish were got almost every day up to the 20th, when the net-fishing closes. One weighing 15 lbs. was got on the 20th of September on Stanley Water by Mr. F. Martin when angling; and another was caught while we were netting for ova. In October some of these fish reach the weight of 30 lbs., and, as was said above, begin running about the middle of July and cease in December. The earliest of these fish have been in the sea for two years and two and a half months, and the latest of them for two years and seven months. Those that survive spawn, become kelts, and go back to the sea in November and December (1907). Taking the end of March 1903 as the time of hatching, it will thus be seen that they are four years and nine months old, although if any one had asserted a few years ago that fish were from 12 to 30 lbs. on their first return from the sea after going down as smolts, and had not spawned, he would have been held up to ridicule.

There is still another run of the same marking, April and May 1905. This is the great run of winter or spring fish, which, like the last run, are in the pink of condition and surpass all the other runs of fish. These fish will not spawn till the next November, some of them being in the river over a year before spawning. Many of these large fish find their way into Loch Tay, Loch Ness, the river Ness, the river Garry, and the Spey. A number are also found in the Dee, the Tay, the Tummel; the Wye in England; the Boyne and the Blackwater in Ireland, and other spring rivers, where large spring fish give fine sport at the opening of the season. The two earliest rivers in Scotland are the Tay and the Ness. In some seasons the average weight of the spring fish caught in Loch Tay has been 22 lbs., and in other seasons over this weight.

In this, which I consider almost the last run, the numbers are greater than in any of the others. Many erroneous theories have been put forward with regard to these fish. Many maintain that they return to the sea, and again return to the rivers to spawn, while others think they do not spawn. I have had many opportunities of proving both of these theories to be false. These fish, being in perfect condition, must start in the winter in order to reach their destination by spawning time, as they travel more slowly in the cold weather of winter and spring, and consequently take weeks to get to Loch Tay. Many of them, when delayed by frost and snow, or snow and high water, take months to accomplish the journey. By the end of April the run may be said to be over, and few enter Loch Tay after this date. With the first flood, about the 15th of May, they leave Loch Tay and ascend the river Dochart. Sometimes they may be delayed a month or more for want of water, but when a spate does come they are ready to ascend, and find their way through the river Dochart into Loch Dochart. Throughout the summer and autumn, and as spawning-time approaches, they make their way into the smaller streams which enter Loch Dochart, and there deposit their spawn about the 15th November, and soon after return as kelts. Their age in April is five years. This is their first return from the sea, the earliest of them having been in the salt water two years and six months, and the latest three years. This completes the four runs of the same marking.

From now onwards the number greatly decreases, and only a few stragglers from 27 to 40 lbs. come on till the end of the year. These are from five to six years old. After this there are a few from 40 to 60 lbs. The next year there are none, making the extreme age seven or eight years.

Few of them, however, reach this age, and all these salmon are on their first return from the sea. I know this statement will be challenged by many. We have as yet got no winter-marked fish, because it is not yet time for them to come. They will, no doubt, be got when the fishing opens in 1908. I have come to this conclusion

beforehand from a study of the scales of fish, which I will endeavour to explain in a later section dealing with scales.

What has been said of the marked fish may be put in a condensed form as follows. The fry which were hatched in March 1903 became smolts in April 1905, and migrated to the sea in April and May 1905 at the age of two years. The first run of these returned to the river as grilse weighing from $1\frac{1}{2}$ to 12 or 13 lbs., from the last

FIG. 11.—Stormontfield Ponds on the Tay, erected 1852.

week in May till the end of December 1906. The second run continued to come from the middle of December 1906 to the middle of June 1907, and weighed from 6 to 13 lbs. The third run returned from the middle of July 1907 to the end of December, and weighed from 12 to 30 lbs. The fourth run extended from the middle of October 1907 to the end of May 1908, and weighed from 13 to 38 and occasionally 40 lbs. The average weight was about 20 lbs., but it varies a pound or two from year to year. The fifth run came on in

May 1908 and lasted till December, and their weight was from 20 to 45 lbs. The sixth run, which begins in December 1908, will continue till December 1909. These will be few in number, and will weigh from 30 to 70 lbs. This is the first return of all these runs of fish from the sea, and none of them have yet spawned.

From the books on the natural history of the salmon and the experiments at the Stormontfield Ponds, I, like most other people, was led to believe that grilse returned from the sea the same season

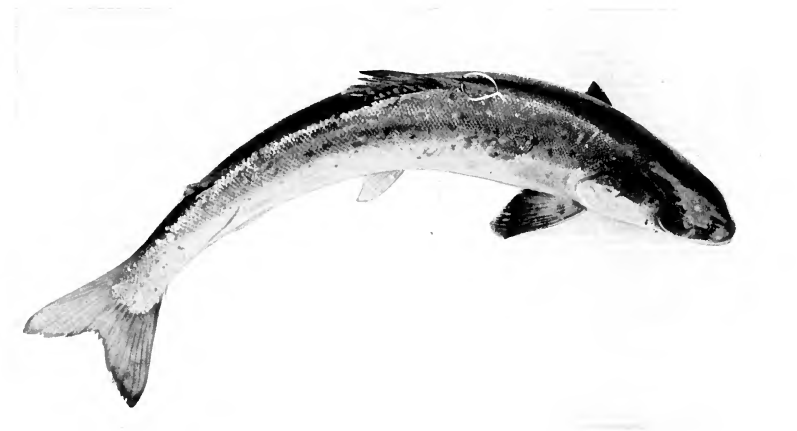


FIG. 12.—Smolt, showing how ring is fastened in dorsal fin. When 25 lbs. this ring is completely filled up.

as they went down as smolts. Mr. Brown, as mentioned in his book of the *History of Stormontfield Ponds*, marked many smolts for several years by cutting off the adipose fin. Many smolts were afterwards captured without the adipose fin, and these Mr. Brown put down as his marking. From a study of scales, however, I concluded that Mr. Brown and others were wrong in believing that smolts returned so soon, for I could find no scales of grilse that had not been more than a year in the sea; and not being satisfied with the various methods of marking fish, I determined to mark them in such a way that they would be known all through life. The cutting off of the

adipose fin I did not consider sufficient, because on several occasions

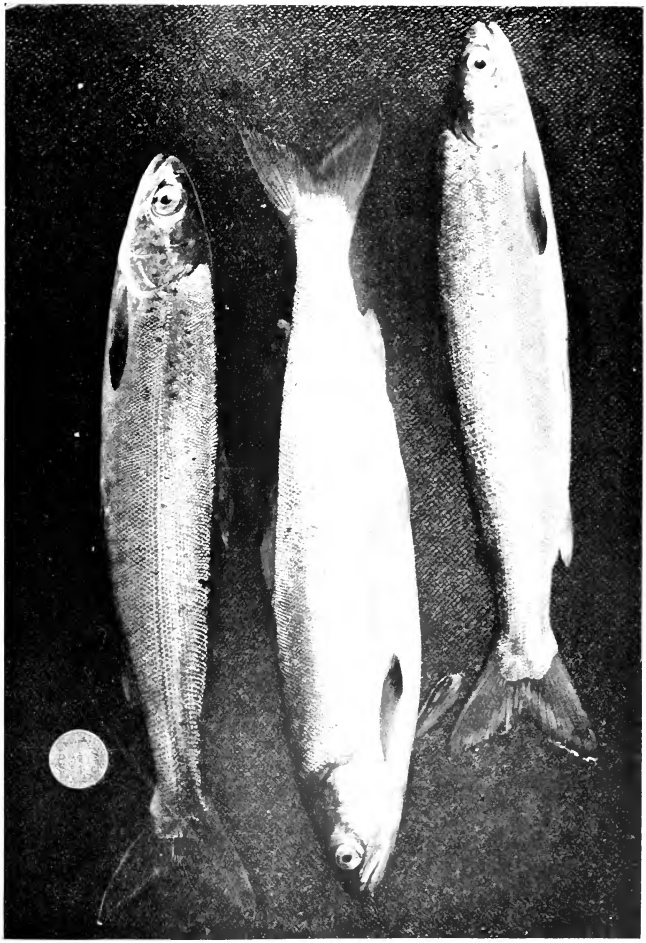


FIG. 13.—Real Smolts, life-size, two years old. Same as marked 1st May 1905.

I have seen fish caught without this fin. Others again pierced the gills, but the aperture thus made soon filled up again. The same

thing happened when a part was cut from the centre of the tail. After a good deal of experimenting I came to the conclusion that the

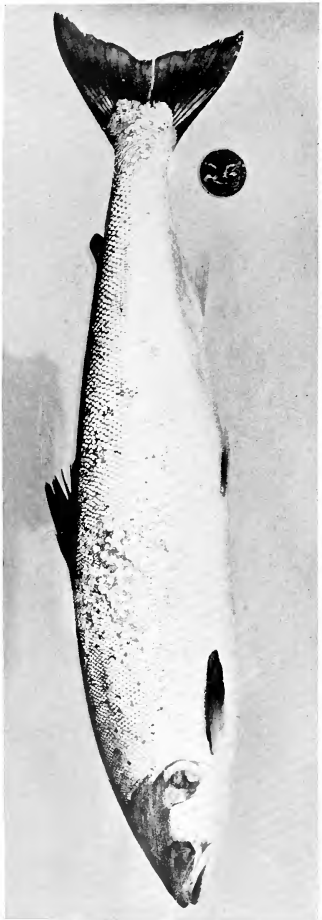


Fig. 14.—First Marked Grilse. Marked as Smolt May 1905. Caught 1st June 1906. Weight 2 lbs. 15 oz. See wire on dorsal fin.

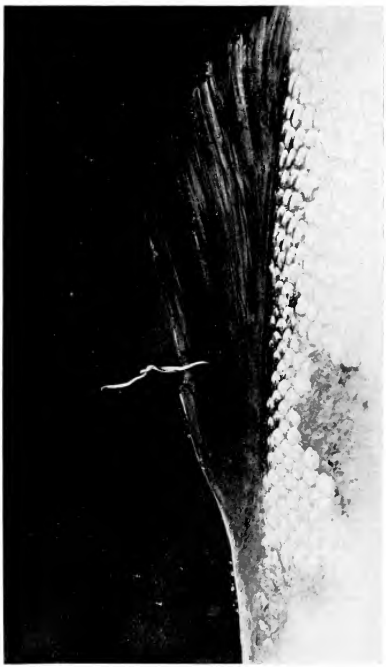


Fig. 15.—Mark of first Grilse, 1st June 1906. 2 lbs. 15 oz. Smolt marked May 1905.

best way to mark them was by inserting a wire through the thick part in front of the dorsal fin. I obtained fine silver wire and cut it into

suitable lengths. Being so fine it was easily pushed through; the two ends were then brought together and twisted round with the

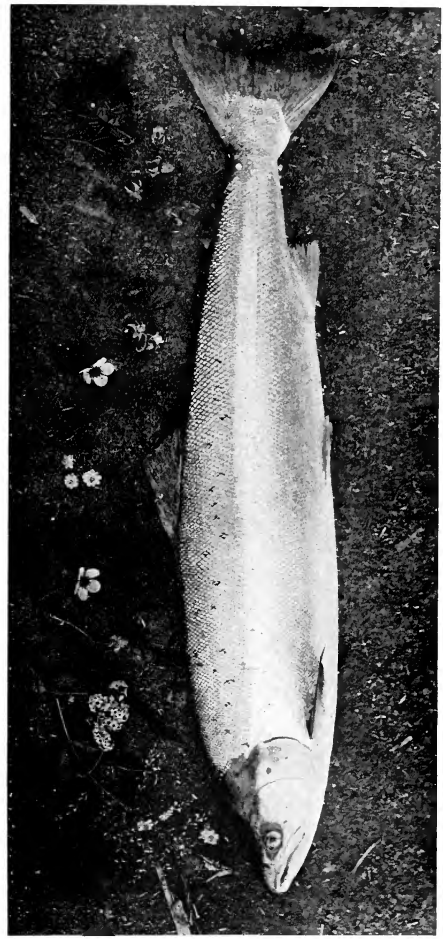


FIG. 16.—Male Grilse, 4½ lbs., caught 26th June 1906. Marked as Smolt May 1905.

finger and thumb, leaving a loop sufficiently large to enable the fish to grow to 25 lbs. before it would fill it up. Figs. 12 and 13 show

marked smolts. One man holds the smolt and another inserts the

FIG. 17.—Female Grilse, 5½ lbs. Caught 4th July 1906. Marked as Smolt May 1905.

wire, the whole operation occupying only a few seconds. Having obtained leave from the Tay District Board and our Tay Fisheries

Company to net the river, we started work on the 1st May and netted the tidal water two miles below Perth, and marked all the

Fig. 18.—Male Grilse, 5 lbs. Tay, 15th July 1907.

smolts we found till middle of June. These were caught with a small-meshed net and put in a box with holes in the bottom. When a

smolt was wanted, the box was raised and the water ran through the holes. One man caught the smolts and handed them to the one who held them in position whilst they were being marked. They were instantly dropped into the river again, and swam away at once. The greatest care was taken to mark nothing but smolts of *Salmo salar*, all parr and yellow fins being rejected; so that so far as we could judge nothing but smolts were marked. I intended all the smolts to be marked in the same place—in the gristly part in front of the dorsal fin; but after a time the markers began to take in two rays of the

FIG. 19.—Marked Grilse, 3¾ lbs., 3rd July 1906. Smolt marked May 1905.

fin without my observing it. On discovering this, I decided to do the marking again another year, as I was afraid the aperture would grow upwards with the fin and the wire would fall out, thus making our work go for nothing. We watched carefully during the whole of the summer, but no marked fish were found. On the 1st of June of the following year we got the first wire in a grilse which weighed 2 lbs. 15 oz. The mark and the fish are shown in Fig. 14. The mark was slightly spoiled with the net. This grilse with the mark on it (Fig. 14) we handed over to the Perthshire Society of Natural Science. The capture of this grilse was the means of making our manager, Mr. David Robb, our Secretary, Mr. Harry Robb, Mr. W. M'Nicol, and Mr. John Robertson

take the greatest interest in the marking, and now all fish that come into our fish-house are examined for wires. This, of course,

Fig. 20.—Female Grilse, 9 lbs. The Tay, 1st August 1906.

entails a great deal of work, for on certain occasions from one to two thousand fish have to be examined in one day. Not only

has a careful record of the dates of capture and of the weights been kept, but all the different classes of fish have been carefully noted down. When there was any doubt about a fish the scales were examined. Few could have the opportunity of capturing or marking the fish so well, as we control the whole of the river Tay, from Stanley to the mouth, and also part of the coast. Practically all salmon caught on the Tay therefore pass through our hands. It was during the net-fishing season, which opens on the 5th of February and closes on the 20th of August, that we had the best opportunity of catching them. Only two have been caught with the rod. The wires have thus served their purpose quite well, and, as was expected, have grown up with the fin (Fig. 16) in many cases, and have remained in it. Those which were put in farther forward have remained farther down. The following are the dates of capture and the weights of marked fish caught in 1906:

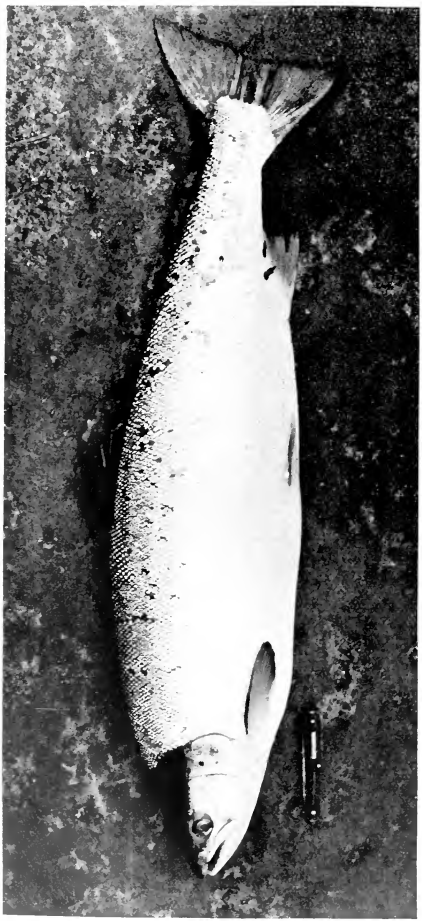


Fig. 21.—Male Grilse, 14 lbs. The Tay, 20th August 1902.

GRILSE

Date of Capture.	Weight in lbs.	Date of Capture.	Weight in lbs.	Date of Capture.	Weight in lbs.
June 1	$2\frac{15}{16}$	July 28	$7\frac{1}{8}$	Aug. 15	$10\frac{1}{2}$
,, 26	$4\frac{1}{2}$	Aug. 4	5	,, 15	8
,, 28	$4\frac{3}{4}$	,, 4	$5\frac{3}{4}$	,, 16	10
July 3	$3\frac{1}{4}$	,, 4	$7\frac{1}{2}$	,, 16	$8\frac{3}{4}$
,, 4	$5\frac{1}{2}$	,, 4	8	,, 16	$8\frac{1}{2}$
,, 10	$4\frac{1}{4}$	,, 7	$6\frac{3}{4}$	,, 16	$8\frac{1}{2}$
,, 14	$5\frac{3}{4}$	,, 8	4	,, 16	$7\frac{1}{4}$
,, 14	7	,, 9	$6\frac{1}{2}$	,, 17	9
,, 16	$6\frac{1}{2}$	,, 10	$5\frac{1}{2}$	,, 17	$6\frac{1}{2}$
,, 16	$6\frac{3}{4}$	,, 11	$8\frac{1}{2}$	,, 18	$10\frac{1}{2}$
,, 17	$4\frac{1}{2}$	,, 13	$6\frac{1}{2}$	,, 18	9
,, 24	$5\frac{1}{2}$	,, 14	$3\frac{1}{2}$	,, 20	7
,, 26	7	,, 14	8	,, 20	6
,, 28	$6\frac{1}{2}$				

The total weight of the forty fish was $266\frac{3}{16}$ lbs. I think these results clearly prove that smolts going down in April and May do not return as grilse until the following year. It has been said that if they do return sooner they must be very small; but I do not believe they return the same year. Even if one were caught, say 1 lb. in weight, it would be impossible to tell, even by the scales, whether it had been to the sea or not. We have on many occasions seen and have caught scores of smolts which have been confined in a loch three, six, and twelve months up to three years after they had turned smolts. These weighed from 6 oz. to 2 lbs. and any of them escaping might easily have been mistaken for young grilse. I will treat more fully of these and give illustrations of them in another section. Our marked smolts, so far as my judgment goes, were all at least two years old in March 1905. In this connection readers might bear in mind that all our captures are from the same marking of 1905.

The difference in weight will be seen from these grilse: the first, caught on 1st June, was 2 lbs. 15 oz., and the largest, caught on 18th August, was 10 lbs. 8 oz. This great difference in weight seems to indicate that the fish both feed and increase in weight much more

during the summer months than they do in the winter months. The

FIG. 22.—Male Grilse, 10 lbs. The Tay, 10th August 1906.

marking of kelts and noting their return prove the same thing, as can also be seen from the scales.

For an opportunity of getting more wired fish we had to wait

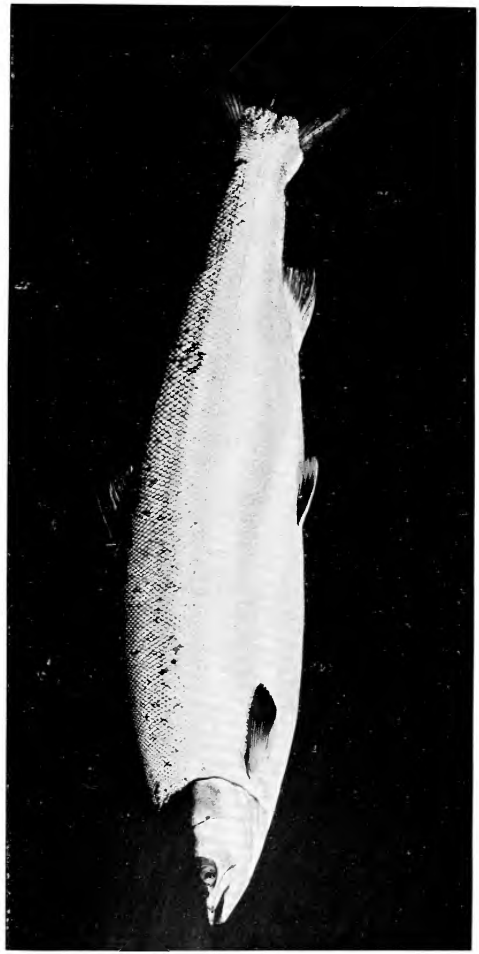


Fig. 23.—Tay Salmon, 9½ lbs. Marked as Smolt May 1905, caught 18th February 1907. First return from the sea. Shows mark on dorsal fin.

until the nets opened on the 5th February the next year—1907. On the 18th of February we got our first wired fish, weighing

9½ lbs. (Fig. 23), and the following day we got another, weighing 8 lbs. From then on to 14th June we got the following wired fish, which

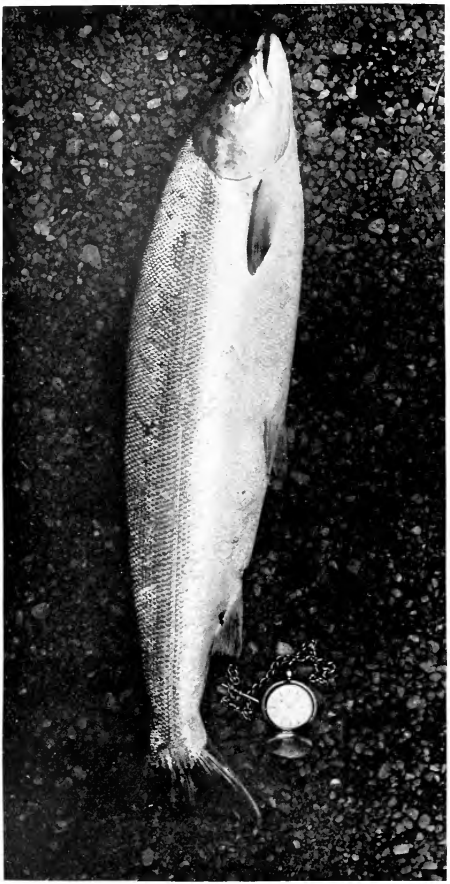


FIG. 24.—Small spring fish, 8½ lbs. 6th April 1907.

were marked as smolts in May 1905, and returned as small spring fish in 1907:—

Date of Capture.	Weight in lbs.	Date of Capture.	Weight in lbs.	Date of Capture.	Weight in lbs.
Feb. 18	9½	April 2	9¼	May 8	7¾
,, 19	8	,, 6	8½	,, 9	10¼
,, 21	9	,, 9	9½	,, 10	8½
,, 22	7¼	,, 11	10½	,, 14	11¾
March 6	7½	,, 23	10	,, 21	11¼
,, 8	7	,, 26	10	,, 23	10½
,, 12	7	,, 29	10½	,, 30	9¼
,, 15	10¼	,, 30	13	June 4	9¾
,, 16	9¼	May 6	12¼	,, 11	11¼
,, 29	13	,, 7	9¾	,, 14	11

These thirty fish weighed in all 292¼ lbs. The above are the dates of the first return of these fish from the sea; and they solved a great mystery, for it was not known what they came from or whether they had yet spawned. I have taken several photographs of these wired fish, which will be reproduced as illustrations.

A little over a month elapsed before we found another wired fish (Fig. 26). The dates and weights are as follows:—

Date of Capture.	Weight in lbs.	Date of Capture.	Weight in lbs.	Date of Capture.	Weight in lbs.
July 18	18½	Aug. 8	14	Aug. 3	17¼
,, 20	13	,, 9	27	,, 5	14
,, 20	16	,, 15	21	,, 5	16¼
,, 22	19½	,, 15	15½	,, 6	14½
,, 24	12	,, 15	14¾	,, 7	17¼
,, 27	17½	,, 16	19	,, 8	16½
,, 31	18½	,, 19	17½	,, 8	12
Aug. 3	15¼	,, 20	18¼	,, 8	15¼
,, 3	18¼				

The net-fishing closed on 20th August. Another fish was caught by the rod on 20th September, weighing 15 lbs., and one 16 lbs. was caught while we were fishing for ova. These twenty-seven fish weighed 449 lbs.

This third run of fish solved even a greater mystery than the small spring fish, for no one believed that these two runs of fish were of the same age, or that there was one run distinct from another; neither was it thought that it was their first return from the sea. These

fish are now—1st August—four years and four months old, and have been in the sea two years and two months since they went down as smolts.

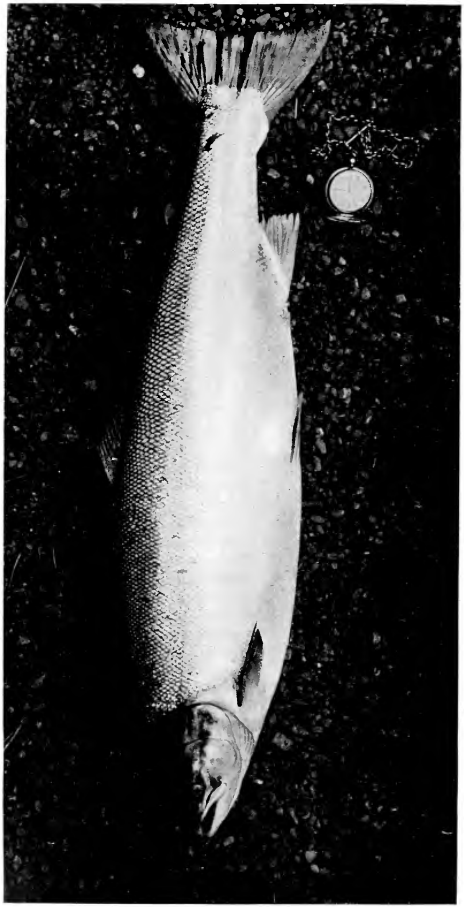


Fig. 25.—Small spring fish, 13 lbs. 30th April 1907.

We had no opportunity of getting more marked fish until February 1908. On 7th February we caught with the net a spring fish weighing 15 lbs. It was newly from the sea on its first return (Fig. 29). On

11th February a wired fish was got with the rod on Faskally Water, weighing 15 lbs.; on 13th February one was caught weighing 38½ lbs.;

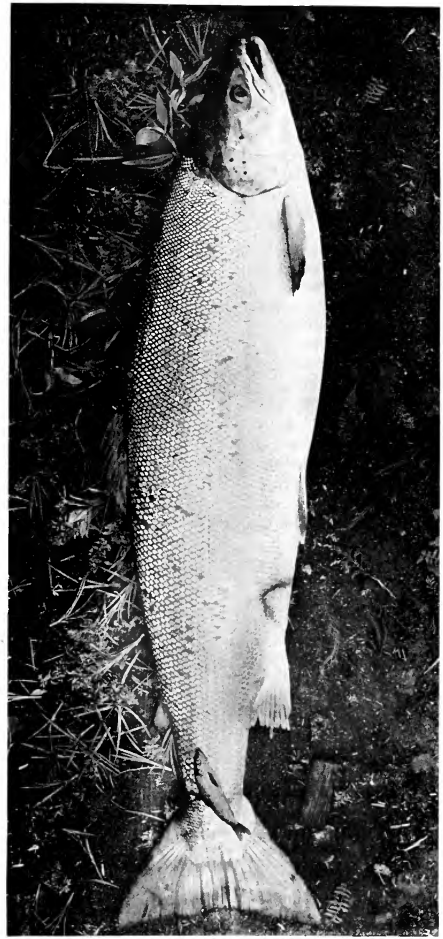


Fig. 26.—Autumn Salmon, 18½ lbs. Caught 18th July 1907. Marked as Smolt May 1905. First return from the sea.

and on 15th February another was got, weighing 13 lbs. (Fig. 31). Still another was got on 31st March and weighed 35 lbs. (Fig. 32).

The history of these fish, which will be five years old in March, is now quite clear. Out of over a thousand fish which I examined during the last two weeks of February, all, with the exception of about ten per cent. which had spawned, were of the same age, viz. five years, and their average weight was about 20 lbs. The one caught on 13th February 1908, weighing 38½ lbs., belongs to the same run and is of the same age, so that up to 15th February 1908 we have these spring fish on their first return from the sea, weighing from 13

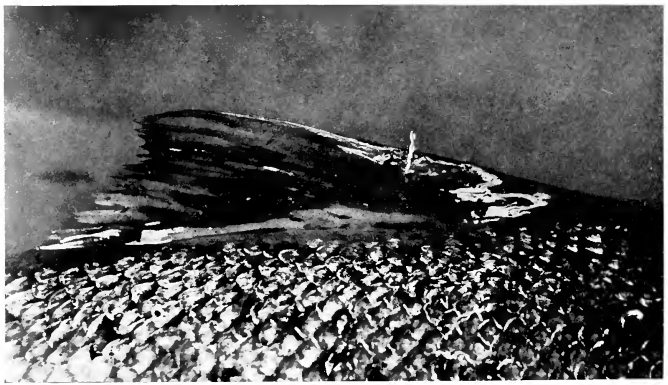


Fig. 27.—Mark of 18½-lb. Salmon shown, caught 18th July 1907. Marked as Smolt May 1905.

to 38½ lbs. The last-mentioned weight is no doubt exceptional. The wired fish, 35 lbs. in weight, caught at Almond Mouth station on 31st March 1908, is the largest marked fish we have got. It had been in the sea within a month of three years, and had not spawned. (See illustration of the fish and of its scale, Figs. 32, 80.) It was therefore of the same age as the others already mentioned, viz. five years.

Although the marking of these smolts and the capture of so many of them has added much to our knowledge, and cleared up many matters of which little was known, something yet requires to be done in marking fish from the different runs in order to be able to tell

whether the new generation do as their parents did. Until this is done we will not know whether the grilse is from the spring or the

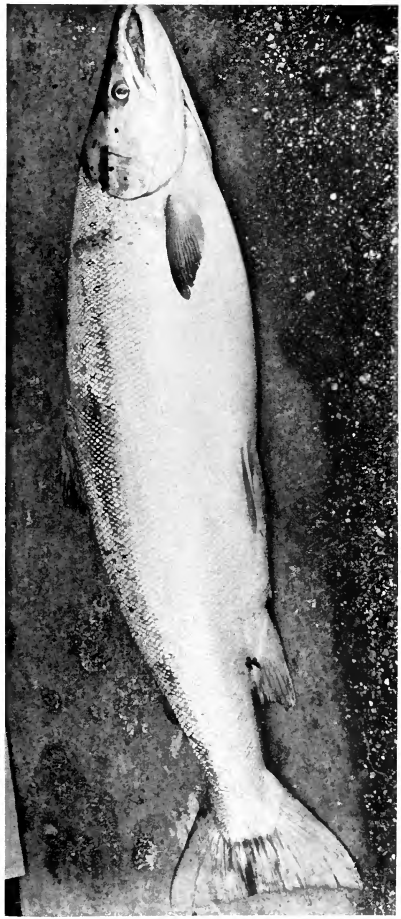


FIG. 28.—Male Salmon, 27 lbs. 9th August 1907. Marked as Smolt May 1905. Largest caught up till this date. First return from the sea.

autumn run, or whether the small spring run is from the large spring fish or the autumn run. This spring, when the smolts from ova taken

from autumn fish were liberated from the Stormontfield Ponds, I

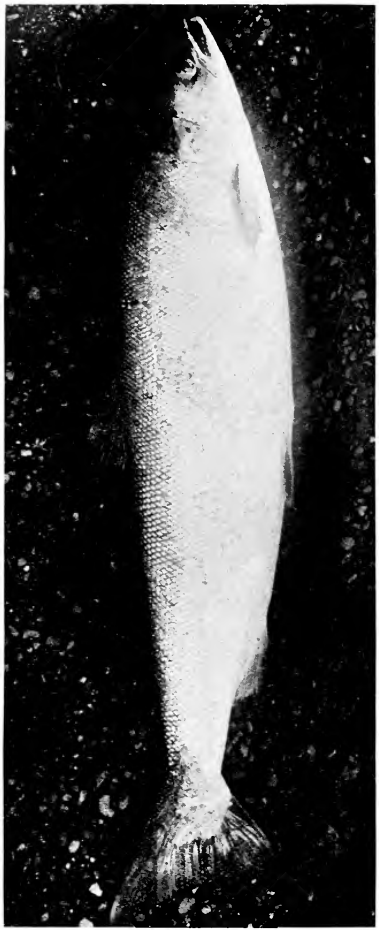


FIG. 29.—Large Spring Salmon, 15 lbs. First caught, 7th February 1908. Marked as Smolt May 1905. First return from the sea.

intended marking them, but something happened which reduced the numbers so much that there were not sufficient to mark.

I am fully convinced that many of our fish from 40 lbs. and up-

wards are on their first return from the sea when they are captured in fresh water. I have examined closely for the last eight years all fish brought into our fish-house, and on many occasions I have counted the number of those that have spawned and the number that have not. In the middle of July I found nineteen out of every hundred had spawned, and that all the others were on their first return from the sea. The prime-conditioned fish are those on their first return, and those that have spawned are coarse, and when cut up the flesh is white, hence the reason for their being thought and called

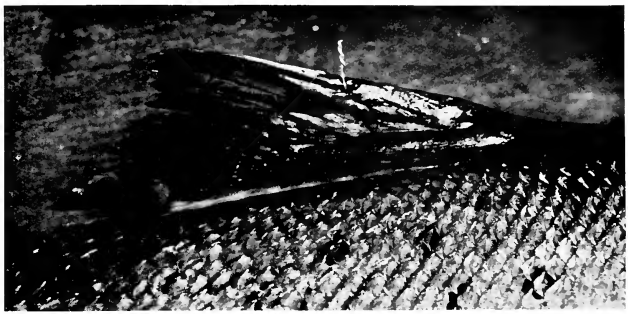


FIG. 30.—Showing mark of 15-lb. Spring Salmon. First caught, 7th February 1908. Marked as Smolt May 1905.

bull-trout. I am afraid I am here giving information which will be valuable to the fishmonger but disadvantageous to the tacksman. It may also be useful to the reader in enabling him to select a prime-conditioned fish for the table. The poor tacksman usually receives a much lower price for what are erroneously called bull-trout. We have now proved beyond doubt that these fish are not a different species, but are true salmon that have spawned. How this should alter their shape and colour is difficult to understand. It may be that the greedy kelt, when its digestive organs come again into action, eats more ravenously, rendering it coarser and stronger than before. The wildest fish that the angler has to do with are, of course, those that have spawned and have returned again as clean fish. This throws some

light on a matter that has troubled many, most believing that if all the kelts were killed there would be no large salmon. By our marking

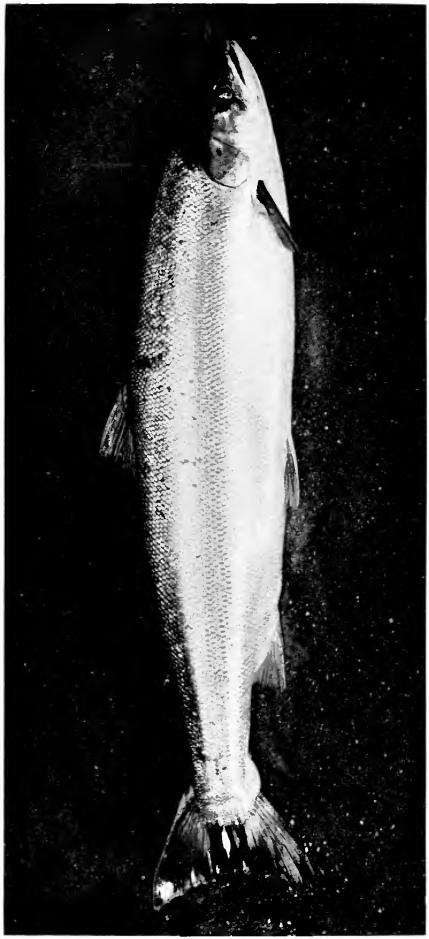


Fig. 31.—13-lb. marked Salmon. Caught 15th February 1908. Marked as Smolt 1905.

however, we have proved that we can have large salmon although all the kelts are killed. This does not mean that we should kill the kelts

for all that; for when we consider that there are nineteen of these in

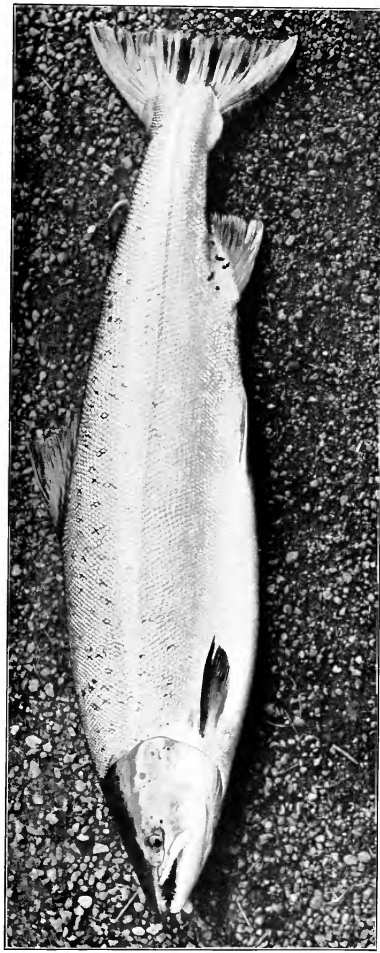


Fig. 32.—35-lb. marked Salmon. Caught at Almond mouth, on the Tay, 31st March 1908. Marked as Smolt, about 1½ oz., May 1905, having been in the sea nearly three years. Age five years.

every hundred clean fish which return from the sea, the kelt is well worth protecting. The proportion is not so great in spring, but I

have no doubt it will be greater after the nets go off. Many people talk of a double migration of fish, which I have never been able to

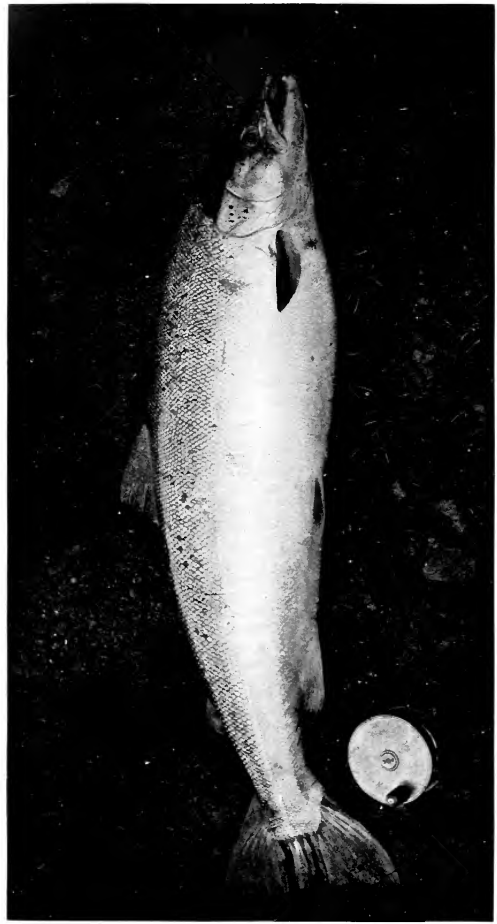


FIG. 33.—Male Salmon, 27 lbs. February 1904. First return from the sea.

understand. Some say the small spring fish are belated grilse ; while others declare they are from an autumn migration of smolts. To put

these theories to the test, we had the Tay netted at different times during the autumn and found none, so that so far as the Tay is con-

Fig. 34.—Tay Female Salmon, 30 lbs. 2nd August 1907. First return from the sea.

cerned there is no autumn migration. No doubt in a dry season many smolts in small burns and lochs are deprived for want of water of a

passage to the sea. Two years ago the Thurso was so dry all summer

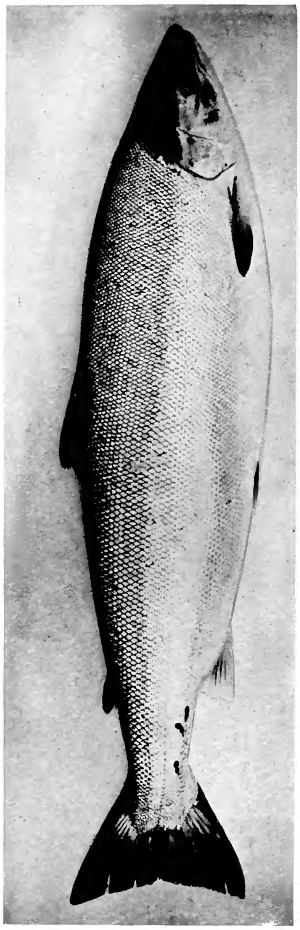


FIG. 35.—Tay Male Salmon, 40 lbs. March 1905. First return from the sea.

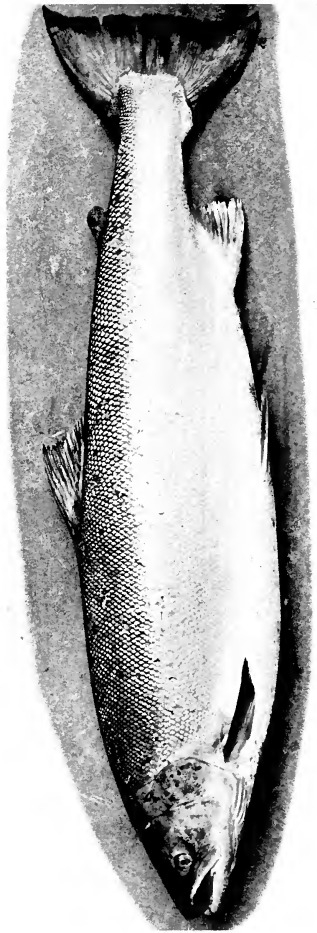


FIG. 36.—Tay Female Salmon, 40 lbs. First return from the sea.

that the smolts did not reach the sea until September, when they were 6 or 7 oz. in weight; but this could not be called an autumn

migration. I think it would be absurd to call the fish a belated grilse we caught on 9th August (Fig. 28), weighing 27 lbs., on its first return from the sea, or a 60-lb. fish arriving from the sea for the first time at the ripe age of seven years.

The marking of the smolts and their recapture afterwards has enabled us to know for certain whether the small spring fish will be plentiful or scarce, and what the other runs that follow will be, long

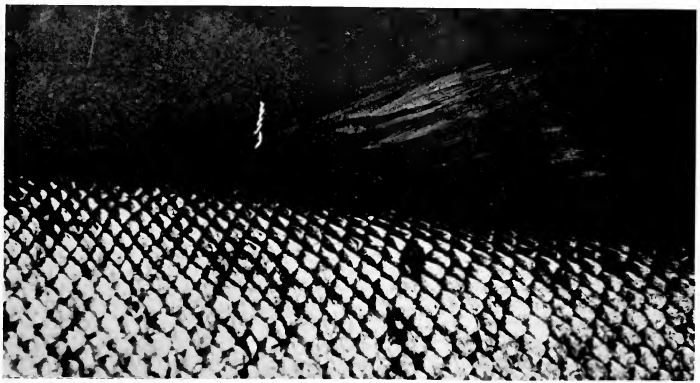


FIG. 37.—Showing mark of first small Spring fish, 9½ lbs., caught 18th February 1907. Marked as Smolt May 1905.

before the fish enter the river, and it also enables us to tell whether the fish will be large or small.

I will now return to the grilse from 4 to 13 lbs. that run from the middle of May to the middle or end of December. These spawn the same season as they come up and become kelts (Fig. 38). Many of them, both male and female, die after spawning, the mortality amongst males predominating. A few of those that return to the sea re-enter the rivers as clean fish, after being three or four months in the sea. On their return about June they are double the weight they were when they went down, and as the season advances the number and weight increase. We know this from marking the kelt grilse. Until a year ago we called all these fish that returned bull-trout, not

knowing the change that had taken place was caused by their having spawned. They are now spotted, and have maggots in their gills. These kelt grilse keep on returning until December, and spawn the same season (Fig. 39).

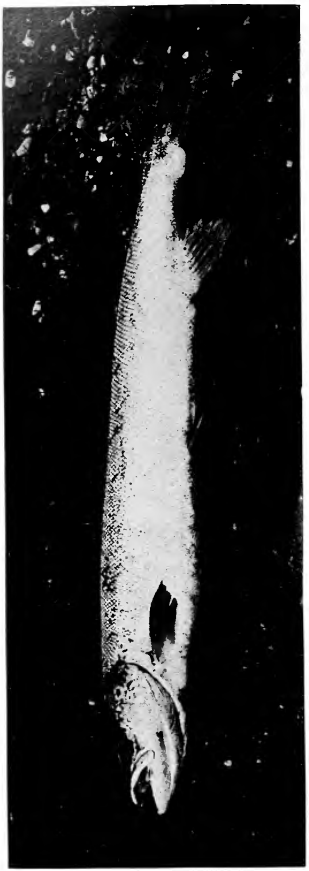


Fig. 38.—7-lb. Female Kelt Grilse. March 1903.

I will now treat of what becomes of the small spring fish kelts (Fig. 40)—those from December to the middle of June. A smaller number of this second run die after spawning than of the kelt grilse. These kelts return during the autumn, winter, and spring, and most of them disappear by the end of April. Like the grilse kelt, they begin to return again about the middle of June; and many of them are of the same size as the grilse kelts—about 5 or 6 lbs. They increase in weight as the season advances, and by September some are caught up to 12 and 14 lbs., according to the weight of the kelt that went down. Strange to relate, almost all the kelts that have been marked on the Tay and recaptured have been females. Particulars of some of these kelts that were marked and afterwards caught in our nets are given below:—

Date of Marking.	Weight in lbs.	Date of Recapture.	Weight in lbs.
April 11, 1906	$5\frac{1}{2}$	Aug. 9, 1906	$11\frac{1}{2}$
Feb. 10, 1903	4	Aug. 20, 1903	$14\frac{3}{4}$

Many others were recorded as being recaptured the same season. See

(1) (2)

FIG. 39.—(1) So-called Tay Bull-Trout, 30 lbs. Second return from the sea, having spawned.
(2) Salmon, 30 lbs. August 1905. First return from the sea, has not spawned.
See the spots on the so-called Bull-Trout. All Salmon that spawn, with few exceptions, become like this. The next time they return from the sea some are more spotted, some less, and nearly all have parasites in their gills. See photo of gill.

Blue-books for 1903-6. It will be observed that these fish were all caught the same season as they went down. It will be seen from the

following, however, that others remain a much longer time in the sea before they return. We find fish of the same marking returning the

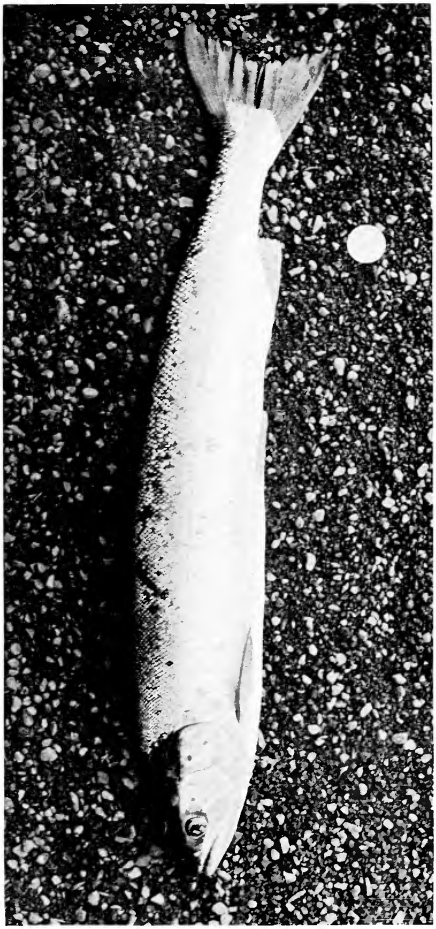


FIG. 40.—7-lb. Kelt, small Spring fish. March 1908.

next year. For example, a kelt of 6 lbs. marked on 26th January 1902 was caught as a clean fish of 18 lbs. on 18th March 1903. I selected this

fish as an example because it is impossible that it could have spawned. Others stayed a longer period before returning. A kelt of 8 lbs., which was marked on 17th January 1902, was 20 lbs. 3 oz. when caught as a clean fish on 18th August 1903; while another of 3 lbs. on 31st January 1906 was 11 lbs. on 27th April 1907. Kelts marked on other rivers give much the same result, showing clearly that they remain longer than a year in the sea, thus continuing the same habits as they had after going down as smolts. Their growth is remarkable, for although marked as kelts in January, they may not have entered the sea till April. The 6-lb. one has increased to 18 lbs.; and another of 6 lbs. caught on 20th August of the same year, which has become $14\frac{3}{4}$ lbs., may not have been in the sea more than four months. This increase is not so remarkable, however, as that of the small smolt going down, weighing 1 to 2 oz., in April or May 1905, and returning on 9th August 1907, 27 lbs. in weight! This I consider the greatest increase that is known of any marked fish of the salmon kind. Those running after July are larger—from 12 to 20 lbs.—and all spawn and become kelts. Many of them die after spawning. The following are particulars of some of these marked kelts (Fig. 41):—

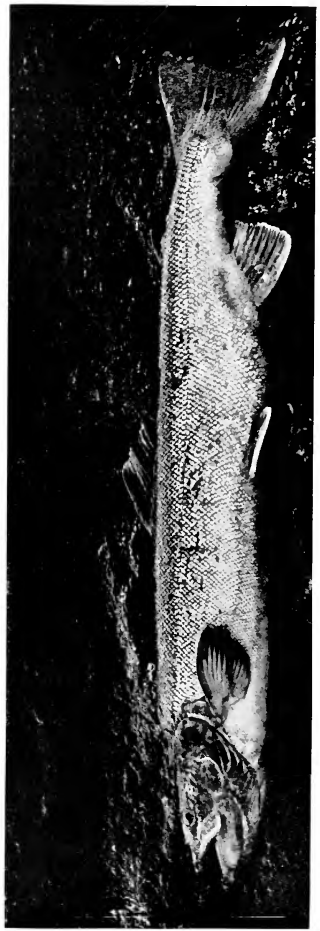


Fig. 41.—Female 12-lb. Kelt Autumn Salmon, immediately after spawning. The Don, 11th February 1900.

Date of Marking.	Weight in lbs.	Date of Recapture.	Weight in lbs.
Feb. 14, 1906	12	Aug. 4, 1906	$20\frac{1}{2}$
Jan. 16, 1906	11	July 25, 1906	$24\frac{3}{16}$
Jan. 19, 1906	$12\frac{1}{2}$	May 18, 1907	$23\frac{1}{2}$
March 8, 1905	13	July 21, 1906	27

There is not the slightest doubt that the short and the long period in the sea are common to all the different runs. I need not, however, pursue this matter further, as it would be confusing, for the next run of fish would be pretty much the same. I will endeavour, when describing the scales, to give more information as to the time these fish remain in the sea after having been in the river as clean fish. The marking of so many fish in different rivers and their capture afterwards prove that almost all fish return to their own native river. A few have certainly been got a considerable distance from their own river, but it is probable that even these would have found their way back to their own river had they escaped capture. This, then, is a good guarantee to those who have charge of any river, that whatever improvement they make is for the benefit of their own river and not for those of other people.

Since writing the above we have seen the close of the netting season of 1907; and from the marking of the smolts and its results most valuable information has been obtained respecting the supply of salmon in after years. The year 1905 was a good year for smolts; 1906 was therefore a good year for grilse; 1907 was a good year for small spring fish; from this I expected that 1908 would be a good year for large spring fish, and such has been the case. On the other hand, 1907 was a bad year for grilse, and I accordingly suspected that 1908 would be a bad year for small spring fish; and this year 1908 being a good grilse season, will also be a good year for small spring fish in 1909, and a good year for large spring fish in 1910. This will apply both to England and Scotland, and so well do we know this now that I can almost tell what proportion of fish will follow in the different runs from the number of grilse captured.

On 5th July 1909 we caught in our nets on the Tay a female fish of $26\frac{1}{2}$ lbs. (Fig. 42), one of those marked as a smolt in May 1905.

From the general appearance and by a study of the scales it is evident that this fish had spawned. After going down in May 1905 it had re-

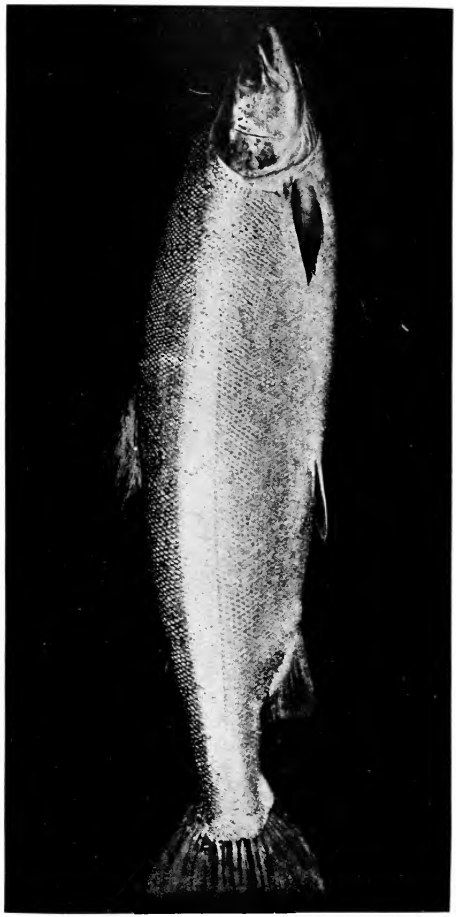


Fig. 42.—Female Salmon, 26½ lbs. Marked as a Smolt May 1905. Caught on 5th July 1909.

mained in the sea for a period of $2\frac{3}{4}$ years, had come up, spawned, and returned to the sea as a kelt in March, and re-entered the river on 5th July

1909, when it was caught. It will thus be $6\frac{1}{4}$ years old. The photograph shows the spots near to the gill-cover, which is a certain sign

FIG. 43.—Scale of $26\frac{1}{2}$-lb. Salmon (Fig. 42). Marked as a Smolt May 1905. Caught 5th July 1909.

of the fish having spawned. This is the most important marked fish we have got, more than a year having elapsed since the last of the same marking was captured. It was got in March of the previous

year and weighed 35 lbs., although it was more than a year younger than the one just caught, the difference in weight being due to the fact that the younger one had not spawned. The weight of the present one was reduced while spawning, and had to be made up again.

We show a print of the scales of this fish (Fig. 43), which is very interesting. Before going down to the sea as a smolt it would have the usual number of rings on the scale, viz. 32. While in the sea it put on 43 rings, but during the four months it was up the river no further increase took place. From its second return to the sea in March until its capture, other 20 rings were added. If 5 be added for the time the fish was in fresh water we get 100; now divide this by 16 and it gives 6 and 4 over, which, according to my 16-rings-a-year principle, gives $6\frac{1}{4}$ years, which, as we already know, is the exact age of the fish. The age can also be ascertained by noting the winter and summer marks on the scales, but as marks are made during summer and resemble winter marks, it is not reliable and constantly leads to mistakes. The counting of the rings, therefore, is by far the most reliable way of telling the age of a fish and the time of its coming from and going to the sea. I have on many occasions proved this by marking fish at various times.

On 8th July 1909 we got another wired fish of the same marking, a female of $28\frac{1}{2}$ lbs. It had returned to the river and gone to the sea at the same time as the last one, but had come up the river again three days later. On examining the scales I find the numbers at the various stages to be 32, 43, 20; and adding 5 for the time it spent in fresh water we have again the total of 100. Another marked fish, weighing 36 lbs., captured on 2nd August, had the same number of rings. Besides these three fish we have, during the last few days, been capturing others similar that have not been marked.

Habits of the Salmon

Salmon run at all seasons of the year. In large rivers like the Tay the clean winter or spring fish begin to run early in October. They do not spawn until the following year, thus being thirteen

months in fresh water before spawning. They push on to Loch Tay during the winter and spring months, and by the end of March the run is nearly over. The average weight of these spring fish is about 20 lbs., though in some seasons they are heavier than in others. A number of them remain in the Tay and its tributaries, the Tummel, the Lyon, and the Earn, until about the middle of May, and give good sport to the angler. After this time they nearly all proceed to the higher reaches. Those already in Loch Tay remain in it until about the middle of May, but when the snow begins to disappear from the hills they leave the loch and proceed up the river Dochart. By this time many of the fish are of a copper colour. Most of them will have left Loch Tay by the end of May, and if there has been sufficient water to take them up after entering the Dochart they gradually advance higher and higher, until Loch Dochart is reached. There they remain until spawning-time, after which they leave the loch and run up the tributaries. The spawning-time begins about the 15th of November, and is usually at its height about the 20th of November. After spawning they become kelts; and the survivors fall back into Loch Dochart, and gradually go down the Dochart into Loch Tay, and thence down the river Tay to the sea, a distance of 120 miles. Being so long in fresh water without food, these fish are reduced to quite half the weight they were when they first came up.

During the winter months, if the weather is cold, these fish travel very slowly, going at the rate of 2 to 3 miles per day; but as the season advances and the weather becomes warmer their speed increases, and by June they will travel 20 miles per day. Towards the middle of July again they begin to move more slowly. Many people wonder why they run in winter and spring, thinking it cannot be to spawn, as there is little appearance of spawn in them. There is little doubt, however, that it is to spawn, and if they did not run in winter and spring they would not be able to reach the head-waters in time, as frost and high and low water would keep them back. As it is, it takes them almost their whole time to reach their destination. Having so much energy they are able to ascend falls and surmount obstacles that autumn fish could not

do even although possessed of the necessary energy, for the spawning season would be on them long before they had arrived at the upper reaches, and if the river Dochart had to depend on autumn fish alone none would ever be got in it. I have always held the opinion that a certain proportion of each run of fish should be allowed to pass, so that all the different parts of the river would be equally well stocked. Until recently there was a large portion of the Tay and a part of the Lyon and the Tummel with very few spawning fish on the beds during winter.

It is a peculiar fact that as long as the temperature of the water is low and snow is in the river, fish have a great disinclination to surmount broken waterfalls or weirs. Few of these fish are seen trying to ascend them before the middle of April. In the river Helmsdale few fish are seen above the falls before April. The only exception to this that I have seen is on the North Esk. On the Morphie weir in February, before the nets go on, sometimes a dozen clean fish can be seen trying to ascend at one time, generally about mid-day, but unsuccessfully, as each one falls back again into the pool below. It is little wonder, however, that these fish try to get up, as there are thousands of them huddled together in one pool. They collect here during the whole of the winter, and are all scooped out when the nets are put on. It is difficult to imagine how this is allowed to go on year after year. There is surely something wrong when 2 miles of this river below the weir are rented at about £5000, and 30 miles above the weir scarcely bring £500!

The amount of running fish do depends much on wind and weather. In cold, frosty weather or when the river is full of snow they run very little. Ideal conditions are when the river is free from snow and a good fresh wind is blowing. I have known a strong west wind take all the fish from the east end of Loch Tay. Strange as it may appear, spring fish are unable to withstand a high flood, and are sometimes carried a few miles down stream. Occasionally big hauls of them are got with the nets in quiet places to which they have been borne down. This accounts for the fact that the rod-fishing is poor after big floods in spring. Kelts seem to be able to withstand floods better

than clean fish, for no matter how many floods there are the kelts remain in the river until they choose to leave, the greater part of them descending during April, while from 15th April till 15th July fish eagerly push forward, few remaining in tidal water. From 15th July fish begin to rest from 6 to 10 miles above tidal water, each succeeding week running more slowly and increasing in numbers in the pools, and as the season advances they begin to rest in the tidal water itself. About the end of September, although they are newly from the salt water and have sea-lice on them, they begin to turn a little red in colour, the spawn increases in size, and they hurry forward with every little freshet. By the end of October they begin to look out for spawning ground, leave the rocky pools, and run up the smaller streams and burns. Although a few begin to spawn in the beginning of November, it is not until the middle of that month that spawning becomes general. During spawning time the female becomes very unshapely and black, and the male red, orange, and black. Their noses become extended, sometimes to the extent of three or four inches; the lower jaw also lengthens and a large hook is formed at the end of it as thick as a man's finger. This fits into the upper jaw, and sometimes almost penetrates it. This extension of the upper and the lower jaw prevents the mouth from closing, and a large opening is shown at each side of the mouth. It has not yet been ascertained what purpose this knob and extension of the upper jaw serves. Some say it is intended for fighting during the spawning season; but it must be a poor weapon of offence, as it would prevent the fish's teeth from coming in contact with its foe. Others say the enlargement of the head is for digging up the gravel; but this is not the case, as the male fish does not dig up the gravel. After spawning time this knob gradually decreases in size, and the extended part has again regained its normal size by the time the fish has returned to salt water.

There are many different and erroneous opinions as to how fish spawn. Having been brought up on the banks of a river where thousands of fish spawned every year, I had ample opportunity of observing and studying them almost every day each winter for over twenty years.

About the middle of November they leave the pools and come on to the streams. Here they select a bank composed of sand and gravel

Fig. 44.—Female Salmon on spawning-bed, turning up the gravel with her tail. November 1904.

which is not very liable to shift throughout the season. Here the female digs into the gravel with her tail (Fig. 44), turns on her side,

and gives a few scoops among the gravel, turning it up with each movement and making the water quite dirty. The spawn, which is being

Photo by H. Anderson.

FIG. 45.—Salmon Spawning-Bed on the Tay.

Photo by H. Anderson.

FIG. 46.—Salmon Spawning-Bed (enlarged).

deposited all the time, falls to the bottom and is covered up with each stroke. This process is renewed every five or ten minutes, the fish work-

ing upstream all the time. If the gravel is easy to work, the spawning-bed thus scooped out is often a foot deep; and by the time spawning is completed the fish will have turned up the gravel to the extent of 2 to 3 yards upstream, and about 2 feet across stream (Fig. 45). The spawning-beds can always be detected by observing the light colour of the gravel which has been newly exposed, contrasted against the

FIG. 47.—Showing Salmon-Beds diverting the water where the gravel is raised, River Duart More, Sutherland.

darker-coloured part on each side (Fig. 46). The whole process of depositing the spawn in the gravel to the depth of 10 or 12 inches occupies from three to fourteen days, according to the state of the weather and the water. So eager are fish to spawn in their own river that I have observed them begin five minutes after entering. If, on the other hand, they are prevented from spawning by being delayed in pools during low water, they retain their spawn for weeks longer than they would have done had the water been suitable for their reaching the

spawning ground. Very often one fish begins to spawn where another left off, and one follows another in this way until the spawning-bed is

Fig. 48.—Salmon, Male and Female. Female turned on her side, turning up the gravel with her tail.

20 or 30 yards long. While the female is working, the male, if undisturbed, remains beside her, and occasionally pushes her sideways

off the bed for a second or two (Fig. 48). If another male come near,

Fig. 49.—Salmon Spawning, Male and Female. November 1904.

however, he rushes after him with his mouth wide open. Although this is repeated each time an intruder comes near, they seldom take hold

of each other. On carefully examining a bed after a fish has spawned, or when it is spawning, one may see a considerable quantity of spawn at the lower end of the bed, uncovered with gravel. This may be either washed away by the first flood, or eaten up by trout or sea-trout.

Conditions of weather and water have a great effect on salmon as regards spawning. A night's frost is the best thing to hasten spawn-

Fig. 50.—Showing Salmon Spawning-Beds on River Almond. November 1905.

ing; while if a freshet come on, even although a fish has begun to spawn, it will leave its bed and go higher up and begin a new one. Fish may be seen spawning at any time of the day or night, but they are most active from sundown till midnight, when they usually leave off and fall back into the pools. Sometimes, if the river is very low, they move up to the spawning-beds as soon as darkness sets in. At such a time their backs may be discerned above water, and you may hear the flop, flop of the female every time she turns on her side

(Fig. 49). Grilse often spawn with salmon, sea-trout with grilse, and trout with sea-trout, in a season favourable for fish running up.

Most of the spawning is over by the end of December, although after a severe winter I have seen salmon spawning in March. If a fish exceeds the time for spawning it becomes bright in colour in the same way as the kelts do, and is then called a "rawner" (Fig. 51). Rawners are sometimes got in the middle of summer, but I have never been able to see one of these fish attempt to spawn. As the bright colour comes on, too, they improve in condition. One can always tell whether they are rawners by holding them up by the tail, for then the spawn will run towards the head. After the male and the female have completed the process of spawning they fall back into the pools, and many of them, more especially the males, become sick and die. The mortality during the first month after spawning is greater than in any other month of the year. During a heavy flood many of them are carried down, lose control of themselves, and soon die, and can be seen in thousands cast up along the banks of most of our rivers. The survivors, if they do not at once return to the sea, remain in the pools from three to four months, assume a silvery dress, and become as strong as clean fish before they return to the sea. In small rivers and the head-waters of large ones fish often return to the sea as soon as they have completed spawning. Most of the fish, however, go down in March and April. A little freshet takes them down in large numbers, and in some seasons, when the river is so low that they are prevented from getting down, they remain in the river all summer.

When kelts are in poor condition they are easily known from clean fish, but as the season advances and they improve in shape and colour it is more difficult to tell them. They nearly always have a few maggots in their gills, their fins and tails are usually ragged and larger than those of a clean fish, and the vent always protrudes. Kelts out of condition are not fit for food, but what the fishermen call "well-mended kelts" before they return to the sea are much better for eating than a dark-coloured fish caught in October. In describing the scales I will show how one may tell at a glance whether

a fish is a kelt or a clean fish. Anglers are often in doubt as to whether fish they have caught are clean or not, and this is not to be

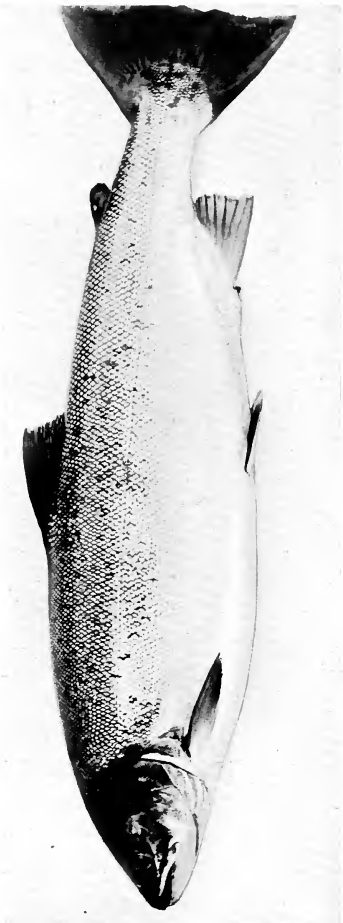


Fig. 51.—25-lb. Female Baggot or Rawner. The Don, 16th February 1899. Has turned bright, like a spring fish.

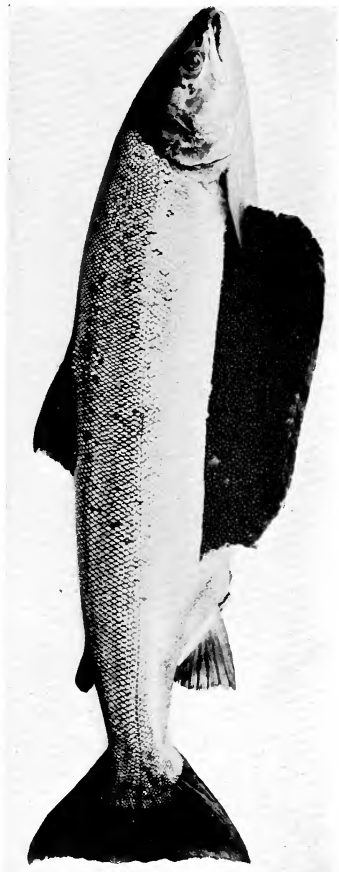


Fig. 52.—The same Rawner, showing the ova.

wondered at, as those who are constantly among them sometimes make mistakes when judging from the outward appearance only.

The size of fish in the different rivers varies very much, and so does the time in which they run into them. In the Tay the spring fish average over 20 lbs., while in the Aberdeenshire Dee they are under half this weight. In the Dee, again, the fish which run in autumn are much larger. Some rivers have no spring run, and some of the tributaries of early rivers have no run of fish till the autumn. This being so, anglers should be careful when renting a river to know when the run takes place. Many are disappointed when they rent a river in autumn to find there are only spring fish in it, which do not take well and are not worth catching. In the Aberdeenshire Dee the average weight is about 7 lbs. They are young-looking and have the appearance of maiden fish with their forked tail and long, small heads.

TABLE SHOWING THE NUMBER OF RINGS PUT ON THE SCALES OF PARR, SMOLT, GRILSE, AND SALMON

Date.	No. of Rings.	Date.	No. of Rings.	Date.	No. of Rings.
April 1, 1903	0	July 5, 1907	68	Dec. 16, 1908	91
,, 1, 1904	16	,, 28	69	Jan. 8, 1909	92
,, 1, 1905	32	Aug. 20	70	,, 31	93
,, 1, 1906	48	Sept. 12	71	Feb. 23	94
,, 24	49	Oct. 5	72	Mar. 18	95
May 17	50	,, 28	73	April 10	96
June 9	51	Nov. 20	74	May 8	97
July 2	52	Dec. 13	75	,, 26	98
,, 25	53	Jan. 5, 1908	76	June 18	99
Aug. 17	54	,, 28	77	July 11	100
Sept. 9	55	Feb. 20	78	Aug. 3	101
Oct. 2	56	Mar. 15	79	,, 26	102
,, 25	57	April 7	80	Sept. 18	103
Nov. 17	58	,, 30	81	Oct. 11	104
Dec. 10	59	May 23	82	Nov. 3	105
Jan. 2, 1907	60	June 15	83	,, 26	106
,, 25	61	July 8	84	Dec. 19	107
Feb. 17	62	,, 31	85	Jan. 11, 1910	108
Mar. 12	63	Aug. 23	86	Feb. 3	109
April 4	64	Sept. 18	87	,, 26	110
,, 27	65	Oct. 8	88	Mar. 21	111
May 20	66	,, 31	89	April 13	112
June 12	67	Nov. 23	90		

The last number would make a salmon seven years old on its first return from the sea.

The Scales of Salmon

The late Lord Blythswood was the first to direct my attention to the importance of the study of scales. During the year 1902 he very kindly sent me several enlarged photographs of scales, which I have still in my possession, drawing my attention to the contraction on a grilse scale. This, he stated, pointed to the grilse having spent one winter in the sea before returning to fresh water. Another scale, showing three contractions, according to his theory, pointed to that particular fish having spent three winters in the sea before returning.

Knowing I had the opportunity of obtaining scales at all times, he was anxious that I should put his theory to the test. Although I had the idea that Lord Blythswood was correct in his assumption, it still remained to be proved by practical experiment. This I immediately set about doing, and devised, after much trouble, to mark the delicate smolt, so that it would return in all its stages with the mark still attached. Up to that time the marking of smolts had been done in a most unsatisfactory and unsuccessful manner; and not until this mark was devised could any reliable information be obtained.

Success attended my efforts; and on comparing a scale taken from the first marked grilse with that of the enlarged photo given me by Lord Blythswood, I found one contraction, proving clearly that his theory was correct. As the season advanced more marked fish came forward, and the older the grilse the more lines could be counted on the scales. Later on came the small spring fish, succeeded by the autumn fish, each run showing two contractions.

Still later came the large spring fish, showing three distinct contractions on their scales. On comparing the latter with the other enlarged photo given me by Lord Blythswood, I found the scales

exactly the same, having an equal number of lines and contractions, denoting they had spent three winters in the sea. The marking of the smolts thus clearly proved what Lord Blythswood wished to point out, that each contraction denoted the number of winters spent in the sea.

This being known, the subsequent reading of the scales was comparatively easy. If reference be made to Figs. 80 and 81 it will be seen that the former had been a year longer in the sea, had grown to 35 lbs., and had more lines on its scale than the latter, which had attained the weight of 18 lbs., and yet both are of the same age, namely, five years. See also Fig. 43 (26½ lbs., 6¼ years old), and two others caught in our nets with my marks intact. These are the only authentic records in existence of smolts having been marked and caught on their second return from the sea. During the whole of the following season a strict watch was kept for marked fish, but none were forthcoming, showing the supply had become exhausted.

My marks, however, had served their purpose well, and added much to our knowledge of the salmon, far beyond our fondest dreams. Lately I have been devoting a great deal of time to examining the scales of fish, in order to find out what percentage of those caught are on their second return, and also to ascertain the number of lines put on when in the sea.

A careful record has been kept during each season and month, but unfortunately last year (1911) was so very dry that fish were unable to push forward in numbers sufficient for my purpose. To give the percentage for any one year, however, I think would be quite misleading, as the large fish cease when the small spring fish begin to increase in numbers.

Each succeeding month also shows a big divergence, double the number of small spring fish being caught in March than in February, and the same rate of increase goes on until May, when the numbers begin to decrease. Then, again, we have some seasons only yielding one-third the number of small spring fish that others yield; therefore,

to give the percentage caught on their second and third return would not be of any great value. What I have said above also applies to the autumn fish. In my opinion, in order to form a correct idea, one would require to keep a record extending over a period of ten years. The number of fish returning for the second and third time caught in the nets on the Tay from 5th February 1911 to 20th August was 872. Of that number 46 were got in February, 26 in March, 15 in April, 20 in May, 51 in June, 323 in July, and 391 from 1st August until the nets went off on the 20th of that month.

In a good season double this number are caught in the nets, and more than double left in the river, besides those caught by the rod. This would mean at least 4500 of these fish returning a second and third time, showing that the much-despised kelt is worth protecting.

It also shows the fallacy of the old theory that if you kill all the kelts you will have no large salmon, for many of the latter are on their first return from the sea, and have not yet spawned. It will be seen from what I have written above that to take and examine a few hundred, or it may be a few thousand scales from fish at intervals throughout the season, and give the percentage, conveys no real meaning. In my first addition I made out that in the autumn as many as 19 per cent had returned a second and third time, figures arrived at by counting the fish twice daily during several weeks. From closer observation, this does not give the true percentage, as I did the same last July (1911) when fish were scarce, and found the numbers far more than 19 per cent—in fact, some days quite 34 per cent. To arrive at the true percentage, one collecting scales would require to examine every fish coming into our fish-house twice daily throughout the whole season. This would be found quite impracticable, especially when a big run of fish had to be dealt with, as thousands would require to be examined daily. One can, however, overcome this difficulty by picking out the fish that have spawned from their outward appearance, and if any uncertainty exist, the gills can be examined for maggots, which are always present.

If we, then, wish to refer to the scales, it is an easier matter to deal with from 4 per cent to 20 per cent than to go over the whole morning or afternoon's catch as the case may be. The small spring fish which begin to run in January, and cease about the middle of June, or perhaps a little later if unable to push forward, are all of the same age, namely, 4 to $4\frac{1}{4}$ years. The autumn run of fish of the same age takes place about the 15th July, and the spring run from the beginning of November, and continues into May.

With experience one can quite well tell from outward appearance the age of these fish, without having to refer to their scales.

For a considerable time I made little headway with the study of scales, until I found out from the parr and the smolt the number of lines added to their scales in a year. This supplied me with a key to Lord Blythswood's explanation, so that after collecting scales from all the different runs of fish, and at all seasons of the year for several years, I was able to tell to within a month how long a fish had been in the sea, and, of course, when it went down as a kelt, and whether it was a grilse, small spring fish, autumn fish, or large spring fish. I could also tell its age and its weight, and whether it had spawned once or twice. This being so, I consider a study of the scales the most important means of determining the life-history of the salmon and the sea-trout.

The study of scales is a very wide subject, but I shall endeavour to condense my remarks as much as possible. Just as the age of a tree may be determined by counting the number of rings on a cross-section of the trunk, where each ring shows the growth of one year, so the age of the parr may be arrived at by counting the rings or lines on its scales. The parr in a natural state, however, adds to its scale each year not one ring only but sixteen, and this goes on throughout all the life-history of the salmon as long as it continues to feed and grow. In the parr fewer rings are put on during the winter months than during the summer months, but if we take a whole year the number works out as I have said, with very few exceptions. I choose a year to calculate from, because if a fish

has rich feeding and has grown to a considerable size it may have as many as twelve rings on its scales when it is only six months old; but notwithstanding this, in March, when it is a year old, it will only

FIG. 53.—April 1905.

FIG. 54.—1 oz. August 1904.

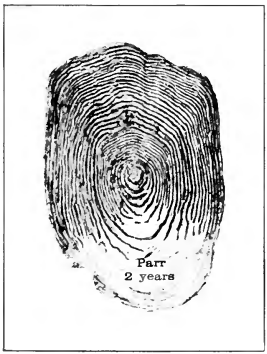


FIG. 55.—1½ oz. Stormontfield Ponds. 19th March 1908.

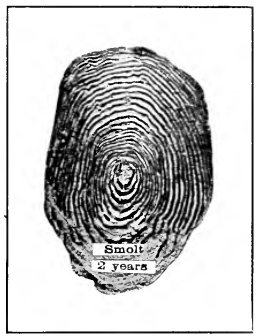


FIG. 56.—1½ oz. April 1905.

have sixteen (Fig. 53). I reckon from March, the time the fry are hatched, and will keep to this month all through. If, then, a parr is hatched in March 1903 its scales will have sixteen rings by March 1904 (Fig. 54), and thirty-two by March 1905 (Fig. 55). It becomes a smolt soon after, and goes down to the sea at the age of two years and one or two months (Fig. 56). We see nothing more of these

smolts until they return as grilse in May or June of the following year, or it may be two to six months later. If, then, a smolt returns on 1st June, after being one year and two months in the sea, how many rings should it have on its scales? On examining the scale we find there are fifty-one rings on it: the same result would have been got by multiplying the age of the fish — $3\frac{3}{16}$ years — by 16, the number of rings which are added each year. I here take 1st June, because this was the date on which our first wired grilse was caught from those which were marked the year before.

Fig. 57.—$1\frac{3}{4}$ lbs. 4th May 1907. North Esk.

Fig. 58.—$2\frac{1}{2}$ lbs. 4th May 1906. North Esk.

I give enlarged photographs (Figs. 57 to 63) of scales from wired grilse, taken each month, which clearly show the number of rings as the season advances. I have also made out a table showing the number of rings on the scales at the different ages. This table will be found to be fairly accurate, taking one month with another. There may be a difference of one or two rings according to the feeding in the sea being better in some months than others; but if more rings than usual are added during any one month, the fewer are added in some of

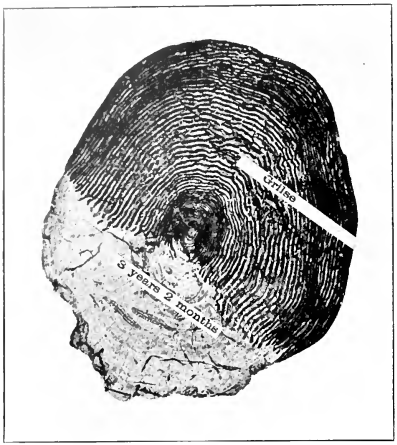


FIG. 59.—3 lbs. 1st June 1905.

of the same age. Very few of the latter, however, are to be met with during November; besides, a spring fish would be readily known without reference to its scales.

As a rule, the greatest number of rings a grilse has is fifty-nine or sixty; although, of course, there may be a few exceptions, in the case, for example, of a parr that did not become a smolt until it was three years old, or one that became a smolt at the age of one year, as some the others. This difference in the number of lines during the different months, however, is hardly worth considering when it comes to longer periods. No mistake need, therefore, be made in distinguishing between a grilse and a salmon, for one has only to count the number of lines on the scales by the aid of a small magnifying glass. If the number is less than fifty-eight it is a grilse. The only other fish that can approach this number is a small spring fish

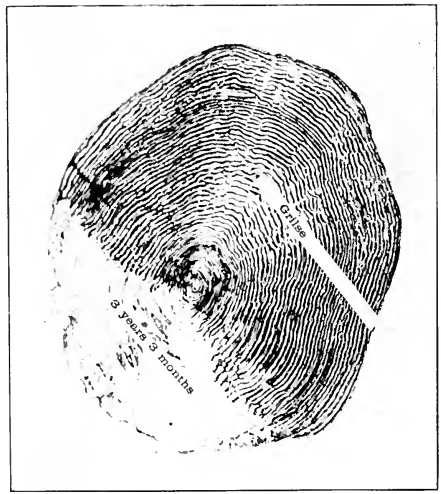


FIG. 60.—Marked as Smolt May 1905. Caught 26th June 1906. 5½ lbs.

FIG. 61.—7 lbs. 28th July 1906. Marked as Smolt May 1905.

FIG. 62.—10 lbs. 8th August 1906. Marked as Smolt May 1905.

maintain they do. This must be entirely exceptional, as I have seldom found it in natural-bred smolts from which I have obtained my information. The scales I studied were mostly taken from smolts caught in the tidal water, and these were true smolts proceeding towards the sea. I have also taken scales from smolts

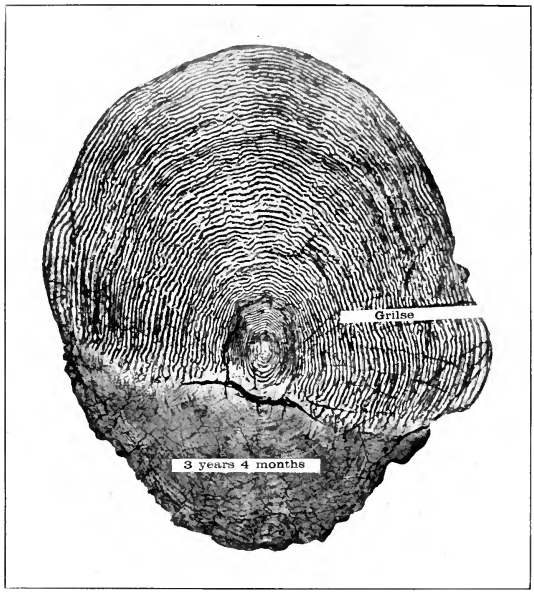


Fig. 63.—10½ lbs. 18th August 1906. Marked as Smolt May 1905.

40 miles from the sea and found no difference in them. Many parr migrate to the sea long before the real silvery coat comes on them, so that it is difficult to tell whether they would become smolts that season or not. All parr and even trout in April and May become quite silvery, almost like smolts. In fact, quite as great a change takes place in the parr when passing from its winter to its summer dress as that which takes place when changing from the parr to the smolt stage. Smolts that are confined in fresh water after assuming

their silvery coat, continue to add rings to their scales just as those in the sea do.

I have never found a grilse in the Tay with a less number of rings than fifty-one, showing clearly that smolts do not return the same year as they go down. All the grilse that come up from June to December spawn, and those that are long in fresh water have both edges of the scales broken off, and by the time they go down as kelts are very much impaired. I have known as many as six or eight rings become detached, the upper edge remaining as it was when the fish came from the sea. When the kelt grilse enters the sea and begins to feed, it at once forms a ring round the broken part as well as round the whole part, and these rings increase in number according to the time the fish remains in the sea. To find the time the fish has spent in the sea, then, we have merely to count the number of complete rings from the broken part outwards (Fig. 64).

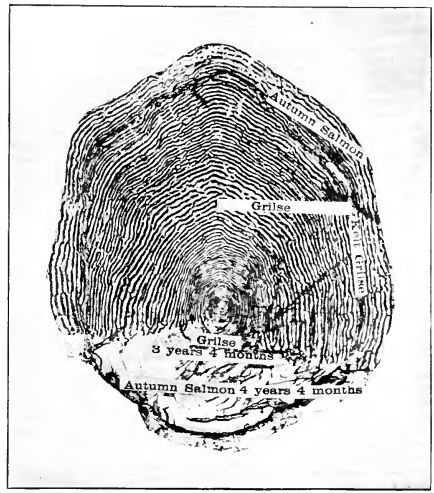


Fig. 64.—7 lbs. 20th July 1907.

For example, a grilse of 7 lbs. weight was caught in August 1906, and its scales contained fifty-four rings. It spawned, and went down a kelt of 4 lbs. on 1st April 1907, and was caught again on 17th August 1907, weighing 9 lbs. The number of rings it had added from 1st April to 17th August was seven, making the total number of rings sixty-one. Its age, therefore, is four years and five months. Had it remained in the sea a whole year, it would have added sixteen rings, and would have weighed about 15 lbs. In calculating the age from

the number of rings one must be careful to remember that while grilse and salmon are in fresh water no addition to the number of rings takes place. On examining the scale carefully where the new rings join on to the old, we find a dark line round the plain part of the scale. This is where the new ring begins.

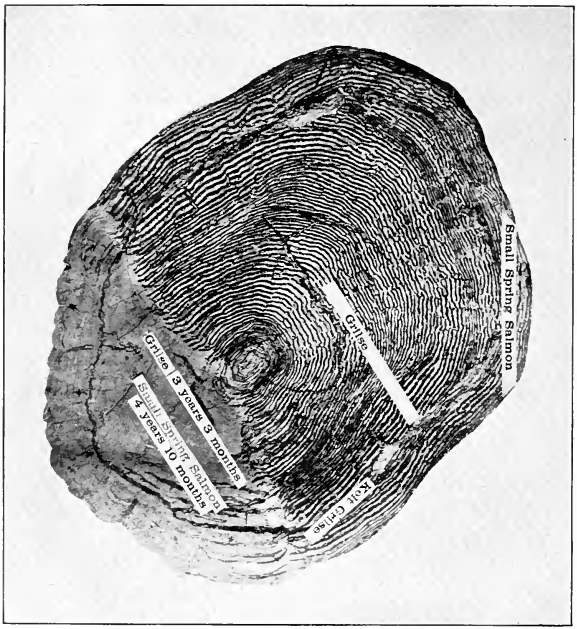


FIG. 65.—10 lbs. 19th February 1907.

During winter, when the fish is in the sea, the rings become contracted, and this is caused, I think, by the food-supply becoming scarcer during the cold weather. This dark mark must not be confused with the dark mark that is made while the fish is in fresh water, caused by the breaking of the scales, which takes place every time the fish returns to fresh water, and is afterwards clearly shown on the scale. It is, however, seldom seen more than three times. Every

time a fish comes into fresh water, it is for the purpose of spawning; so that if a fish comes from the sea three times, it spawns three times. The great majority, however, only spawn once. On examining all the scales of the marked grilse and spring fish, I find that the contracting of the rings generally takes place in January or February, and occasionally in March. In April, again, they widen out, and the width continues to become greater during the summer and autumn months.

By referring to some of the photographs the reader will observe when a fish has spawned as a grilse, gone down as a kelt, and come up as a clean salmon. Count the number of rings that have been put on from the time it was marked to the time it returned, and refer to the number and weight of the fish (Fig. 65). Due allowance must, of course, be made for kelts lingering in the river after being marked. The time need not be extended beyond the 1st of May, as most kelts have disappeared by that time. In almost every instance you will tell, within a few weeks, the time the fish has been in the sea.

I will now deal with the scales of small spring fish which are of the same age as the grilse of the previous year, and will confine my remarks to fish marked by us, including the autumn run as well. The first one caught was on 18th February 1907, and its weight was $9\frac{1}{2}$ lbs. (Fig. 66). Now if this grilse, caught on 1st June 1906, had fifty-one rings on its scales, how many should this February fish have? The answer is sixty-two. Now at the same date the kelt of the grilse of the same age has only fifty-one. This kelt grilse, being on its way to the sea, will add another sixteen rings if it remain in the sea for a year; so that when the spring fish of 18th February is returning to the sea as a kelt, the kelt grilse will be going up the river as a clean fish, and will now have sixty-seven rings on its scale, five more than the 18th February spring fish kelt which is going down. The last marked fish we got of the same age was caught on 19th September 1907, and the number of rings on its scale was seventy-two (Fig. 77). From the enlarged photographs of the scales taken each month, it will be seen, in addition to the number of rings put on each month, where the lines are contracted in some cases, and also where

they widen out again during the summer. No river-mark appears in these scales, because the fish have not been in fresh water since they descended as smolts.

To many it may seem strange that a grilse the same age as this

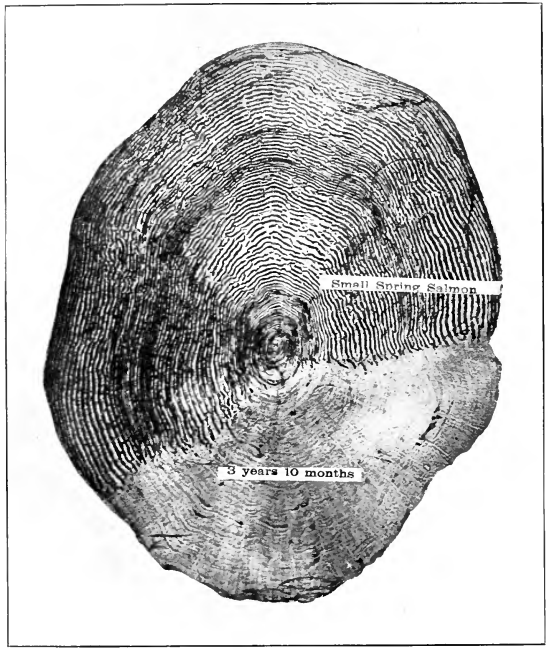


FIG. 66.—9½ lbs. 18th February 1907. Marked as Smolt May 1905.

February spring fish can be 8, 10, or 12 lbs. weight in August the previous year, and this spring fish, after having six months more feeding in the sea, is yet of less weight. It seems equally strange why a fish the same age as the grilse caught on 9th August weighed 27 lbs. Knowing these things, we need not wonder at a fish being caught over 40 lbs. in another year. We have no way of knowing what the weight of the grilse that came up in the autumn

FIG. 67.—10½ lbs. 11th April 1907. Marked as Smolt May 1905.

FIG. 68.—6 lbs. 8th March 1907.

would be on the 1st of June, but we have every reason to believe it would be of the same weight as those coming up in June; and owing to the growth being greater in summer than in winter, twice as much weight is added during the former season. This is seen all through their life-history. The grilse are small when they

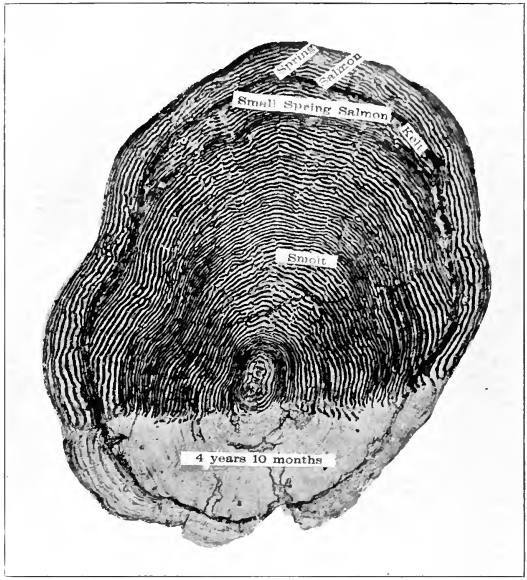


Fig. 69.—10½ lbs. 15th March 1907.

first appear in summer, but by the end of autumn they have increased to four times in weight. The same thing happens with the small spring run. They weigh about 5 lbs. to begin with, and go on increasing until they are 12 or 13 lbs. The increase in weight here, however, is not so pronounced, because this run ceases by the middle of June.

In the next run, however, the weight increases much more quickly,

FIG. 70.—12½ lbs. 6th May 1907. Marked as Smolt May 1905.

FIG. 71.—11 lbs. 14th June 1907. Marked as Smolt May 1905

for a fish of the same age, caught on 18th July and weighing 18½ lbs., may be 27 lbs. in August ; and a winter fish may be only 15 lbs. in October, and yet be 30 lbs. or more by March. It is quite easy to distinguish a small spring fish kelt from a grilse kelt by the increase in

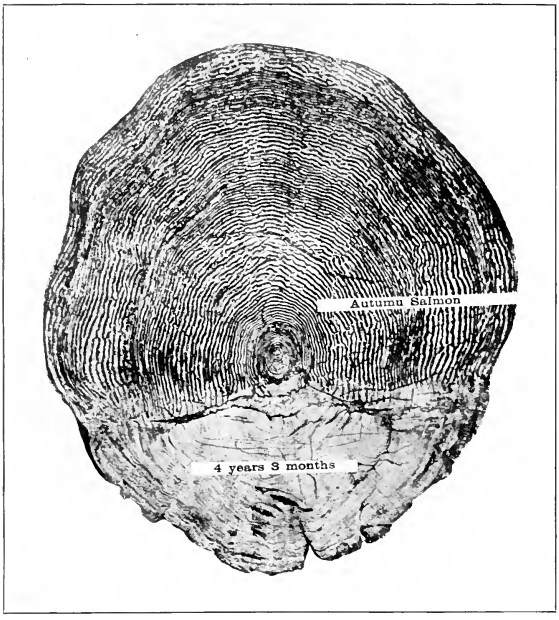


FIG. 72.—Marked as Smolt May 1905. Caught 18th July 1907. 18½ lbs.

number of rings on the scale, and also by its having two contractions on the scale instead of one.

The next run of fish is the winter run, and it begins on the Tay in October and continues till the end of March. The fish in this run are all clean, and do not spawn until the next autumn ; and not having been in the river before, they do not show a river-mark. There are seventy-three lines on the scales on 28th October, and by the end of March there are eighty. The scales, too, have three contractions,

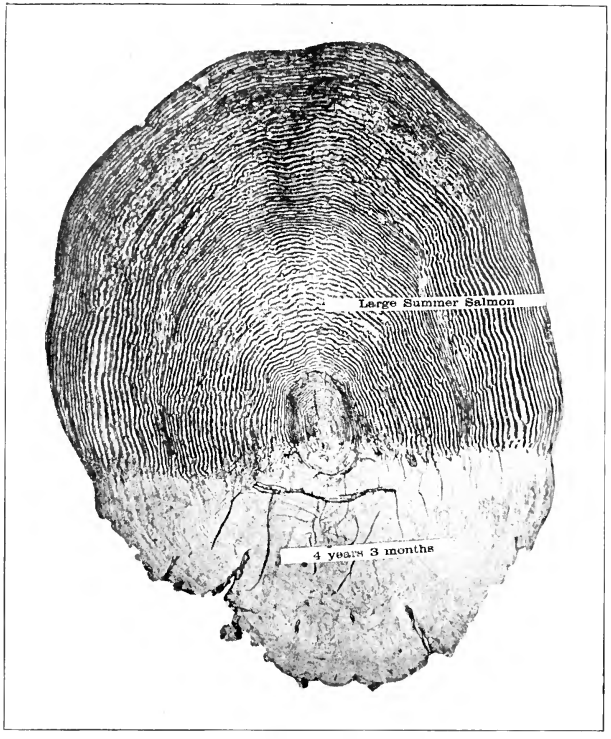


FIG. 73.—27 lbs. 27th June 1907.

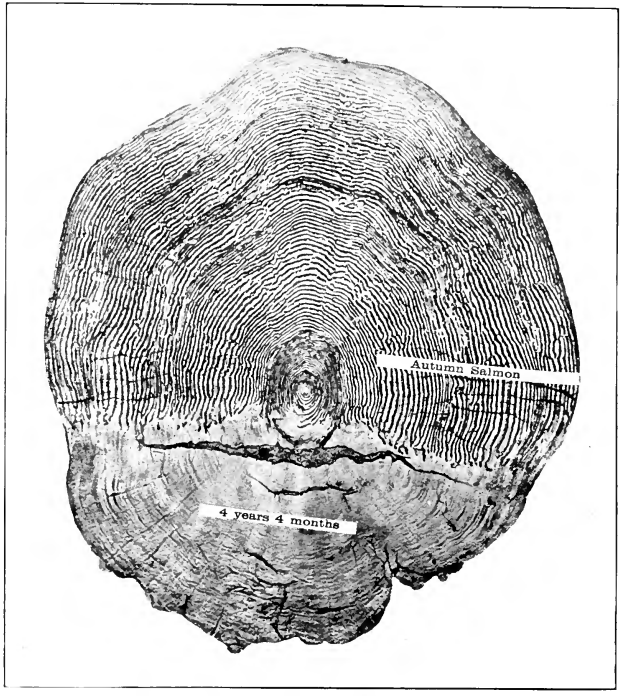


FIG. 74.—18¾ lbs. 3rd August 1907. Marked as Smolt May 1905.

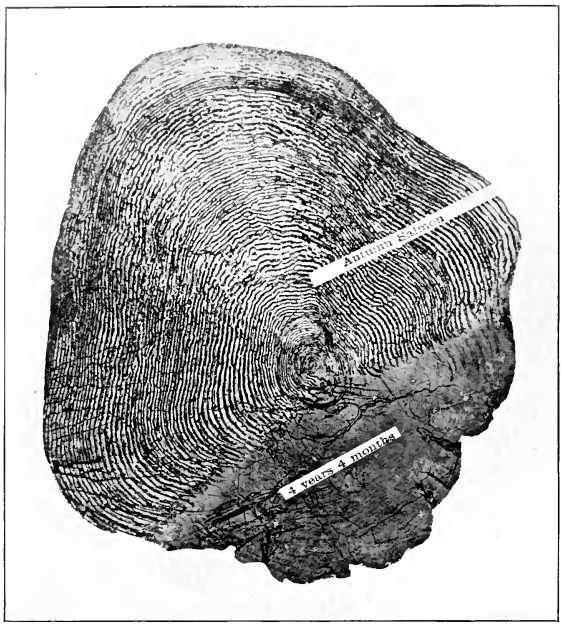


FIG. 75.—18 lbs. 20th August 1907. Marked as Smolt May 1905.

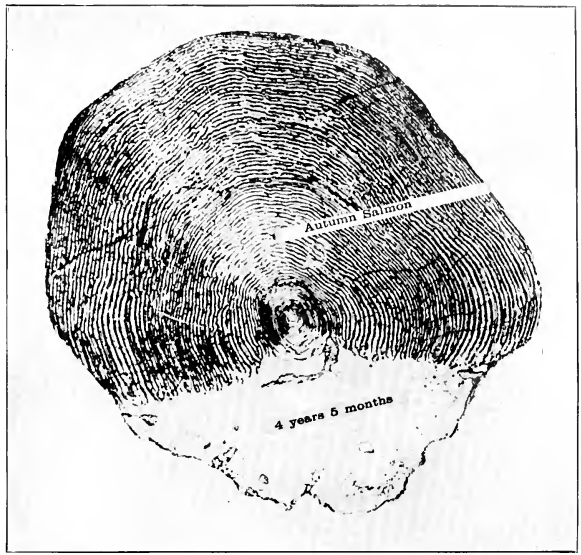


FIG. 76.—18 lbs. 20th August 1907.

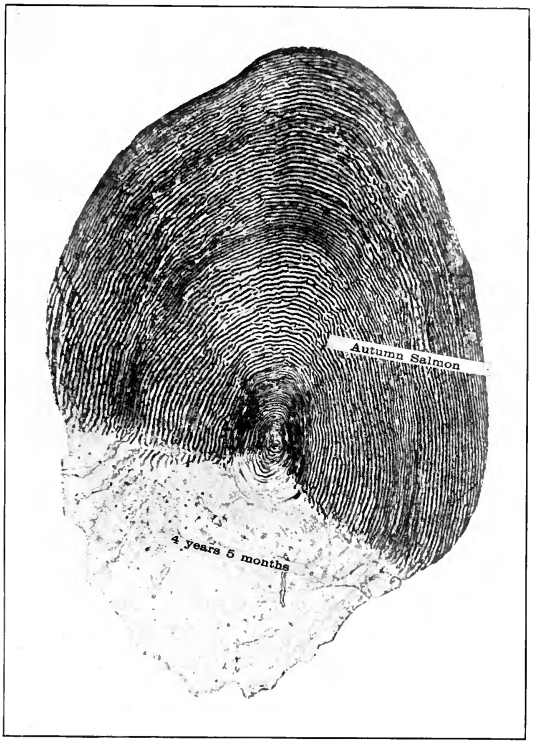


FIG. 77.—15 lbs. 19th September 1907. Caught with fly by M. T. Martin, Esq., at Stanley. Marked as Smolt May 1905.

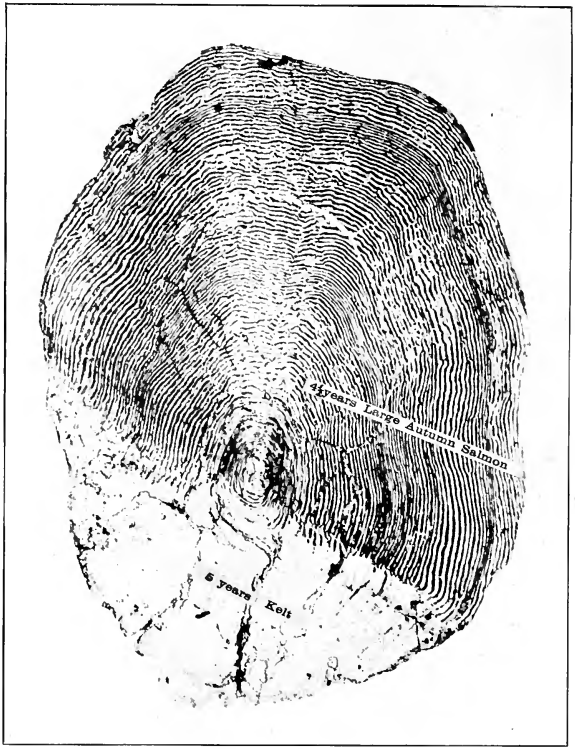


FIG. 78.—14-lb. Kelt. 27th March 1906.

showing that the fish have been three winters in the sea. They can thus be easily distinguished from the last run. The kelts from the

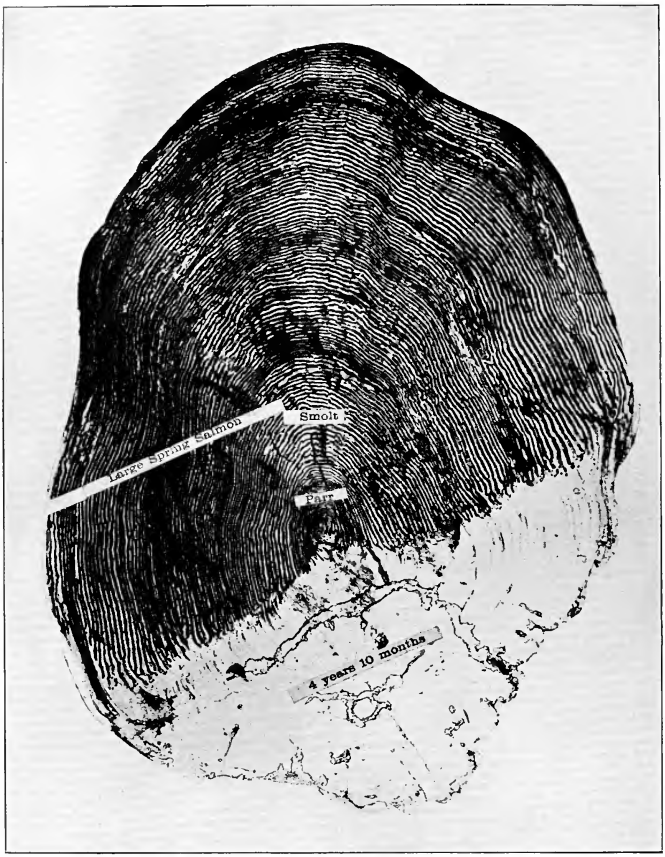


Fig. 79.—38½ lbs. 13th February 1908.

spring fish are a little larger than those of the last run, but, of course, they do not become kelts until they are a year older. I have tried to ascertain how much these winter fish lose in weight while in fresh

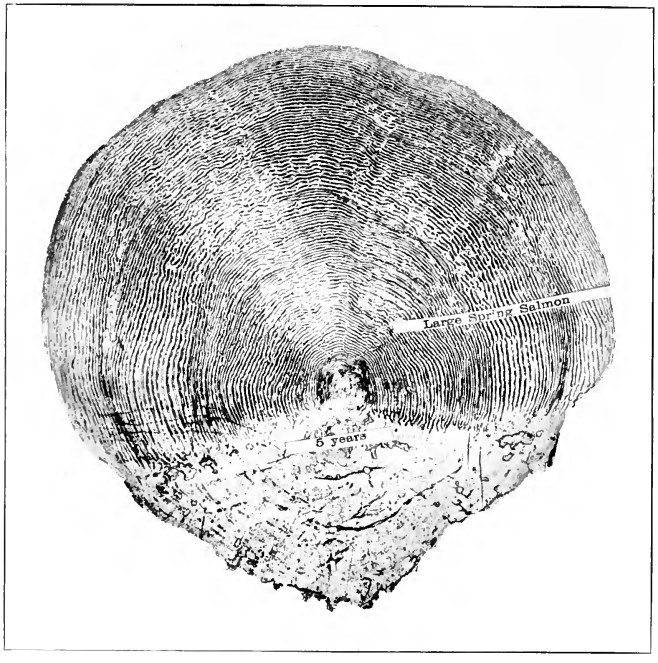


FIG. 80.—35 lbs. Marked as Smolt May 1905. Caught 31st March 1908.
See photograph of fish (Fig. 32), first return from the sea.

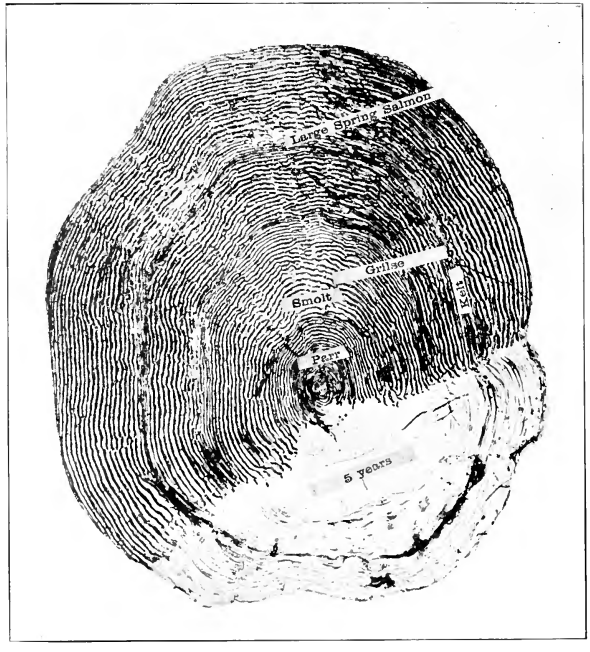


FIG. 81.—18 lbs. 23rd March 1908. Marked as Smolt May 1905.
Second return from the sea.

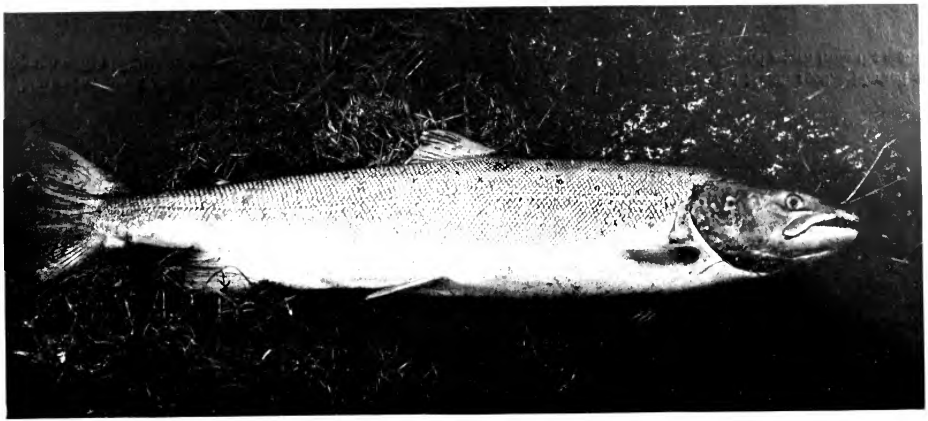


FIG. 82.—14-lb. Female Kelt, immediately after spawning, still showing the dark colour. 24th January 1907.

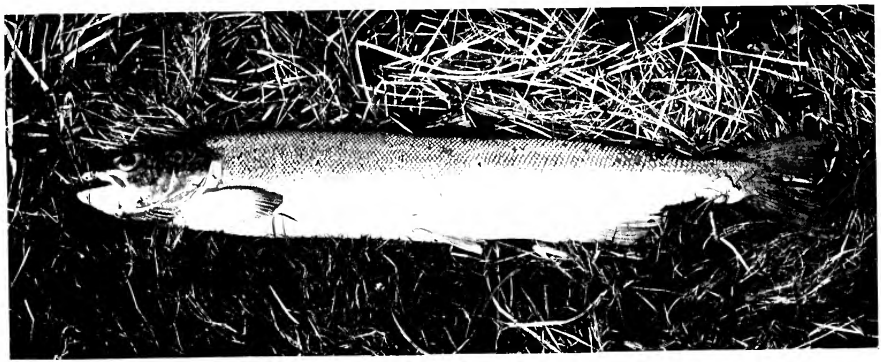


FIG. 83.—12-lb. Female Kelt, soon after having spawned. 24th January 1907.

water, *i.e.* from the time a clean fish enters fresh water until it returns to the sea. Some of them are a whole year in fresh water before spawning, and, as nearly as I can make out, lose twenty-five per cent

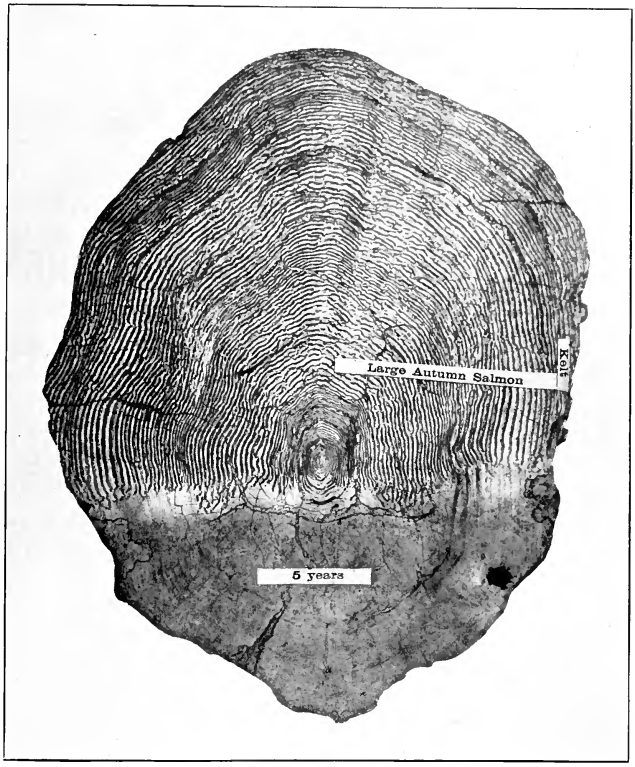


FIG. 84.—14 lbs. 27th March.

of their weight before and after this takes place; so that a fish of 20 lbs. leaving the sea on 1st January 1907 is reduced to half that weight on its return as a kelt on 1st January 1908. This percentage varies with the length of time the fish is in fresh water, and according to the river it frequents.

In the Tay, for example, fish retain their good condition much longer than they do in the Earn, although the latter is a

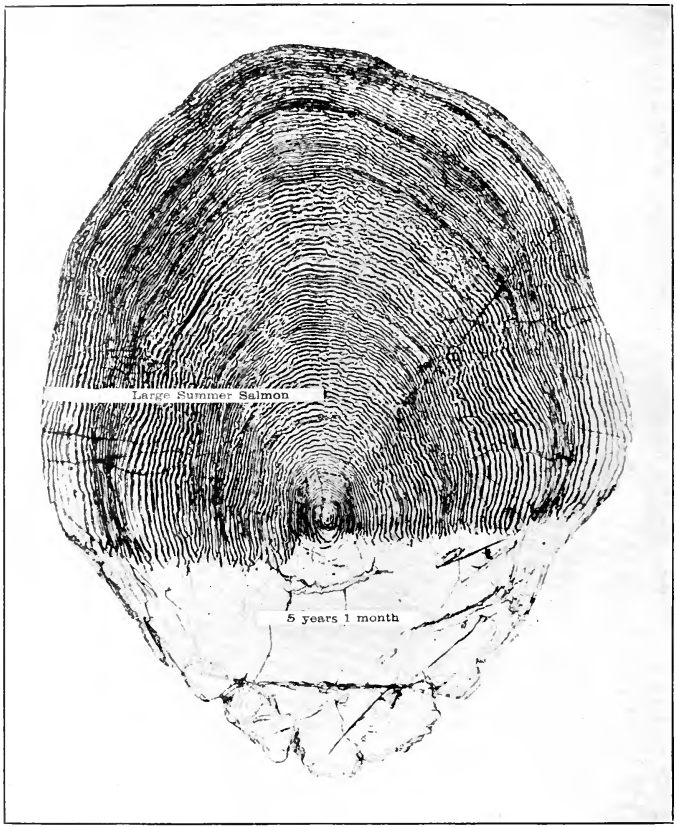


FIG. 85.—40 lbs. 15th May 1906.

tributary of the former. In the Aberdeenshire Don they remain longer in condition than in the Tay; while in the Dee, again, the early spring fish become quite thin and dark in colour as the

season advances. No doubt the quality of the water has something to do with this.

Autumn fish, on the contrary, do not fall off in condition so readily, as their stay in fresh water is of shorter duration. This

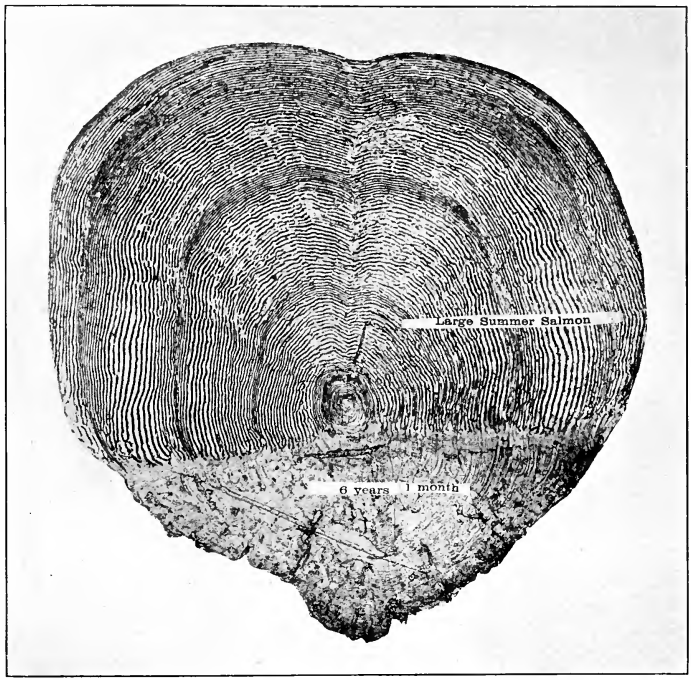


FIG. 86.—57½ lbs. 24th May 1907. See Fig. 128.

is, no doubt, caused by the fact that they cease feeding for a considerable time before leaving the sea. Spring fish entering Loch Tay during winter, retain their flavour throughout the spring, and are always excellent for table use. The scales of fish that have been in the river for nearly a year, become very much broken at the edges before the spawning season commences, and on

returning again as clean fish the joining of the new rings to the old is much more pronounced than it is on those of the autumn run; many of the latter, however, are so short a time in fresh water before spawning and returning to the sea, that very little damage occurs to the scales. When they appear in the river

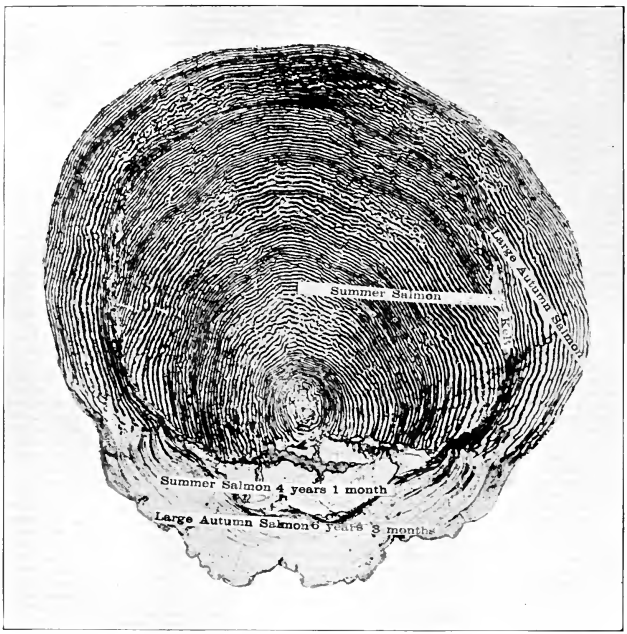


FIG. 87.—Marked 10½-lb. Kelt, 16th March 1906. Recaptured clean, 27 lbs., 8th August 1907.

again, it is therefore sometimes difficult to tell whether they have been in fresh water before or not. In treating of fish falling off in condition, I refer, of course, only to fish that would spawn on entering fresh water. Fish caught in the sea and confined in fresh water, as also barren fish, retain their silvery coat and their good condition for many months. Even at the end of four months little difference in their appearance can be detected.

On 22nd January 1907, whilst angling on the Islamouth beat of the Tay, I caught twenty-four kelts, ninety per cent of which had been a very short time in the river. Their average weight was about 20 lbs., and all were dark in colour, some of them red; in fact, I never before saw fish in such splendid condition. I was so struck with

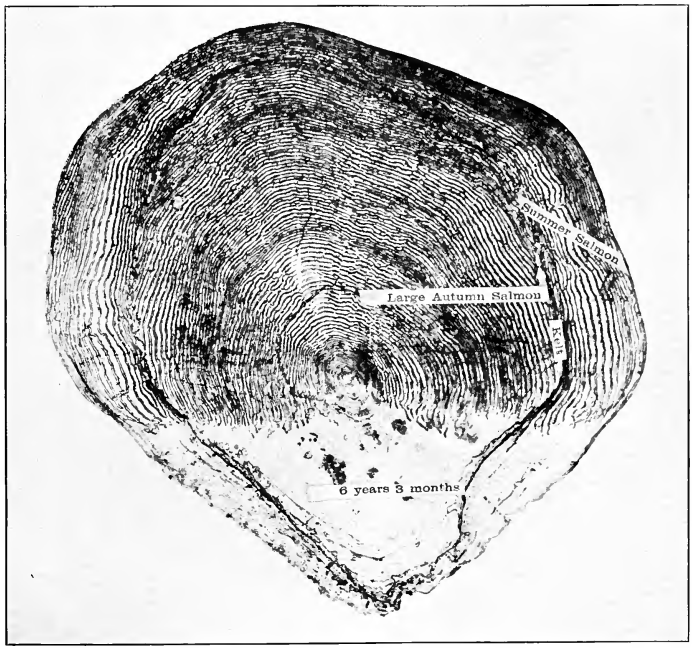


FIG. 88.—Marked as Kelt, 16 lbs., February 1904. Recaptured 18th June 1905, 34 lbs.

their appearance that I went back next day and caught a number, and had them photographed. These photographs I reproduce (Figs. 82, 83). No doubt these fish, caught a little later in the season, would be known as "well-mended kelts," a term often applied to them by anglers. Being black in colour, they are not, of course, so showy as silvery kelts. The other ten per cent were ordinary long,

lank, silvery kelts. As far as my experience goes kelts do not increase in weight during their sojourn in fresh water, although they certainly become much stronger. Their silvery appearance, however, deceives

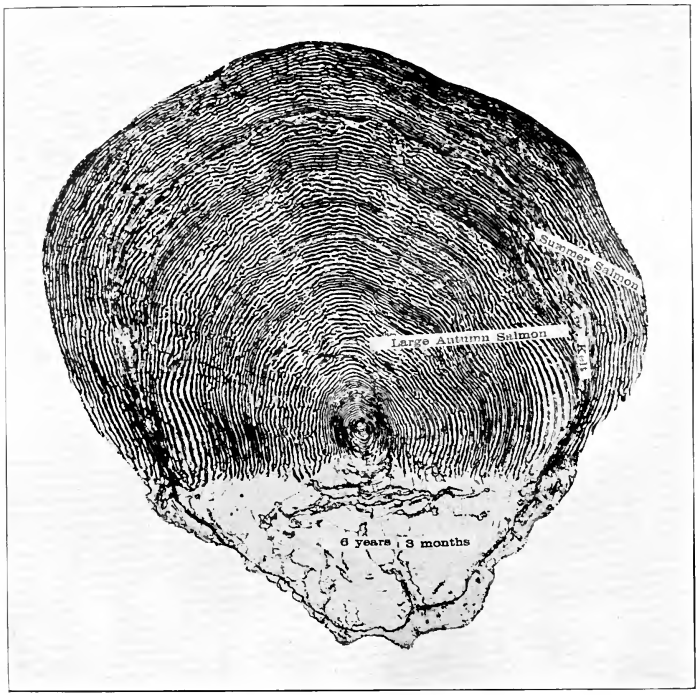


FIG. 89.—40 lbs. 26th June 1907.

the eye, just as a burnished bar of silver appears much larger to the eye than a tarnished bar of the same size.

The scale (Fig. 96) is a very interesting one, as it is taken from the only male salmon I have ever seen in our fish-house on its second return from the sea. Going down as a smolt, it came up a grilse in 1910; descending as a kelt in the spring of 1911, it returned to the

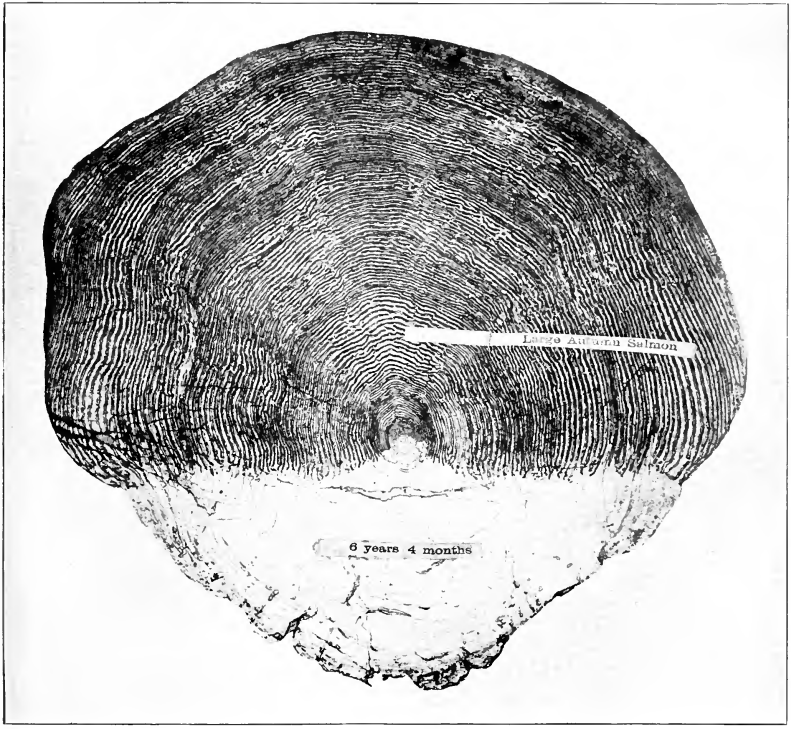


FIG. 90.—47 lbs. August 1906. Shannon. First return from the sea.

river and was caught in our nets on the 20th August. This fish was fresh from the sea, and had sea-lice clinging to it (see Fig. 98).

During its sojourn in the sea ten rings were added to the scale beyond the kelt-grilse mark. The mortality amongst male fish enter-

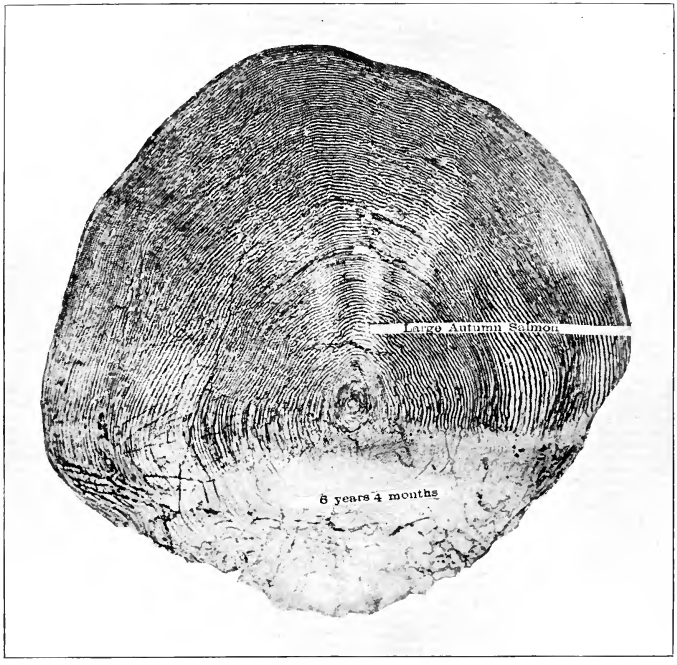


FIG. 91.—50 lbs. 10th August 1907. First return from the sea.

ing a river must be very great, few surviving, as I must have examined 100,000 fish before I came across this specimen.

The fish, Fig. 97, has sixty-four lines on its scale, making it four years old, two of which have been spent in the river and the other two years in the sea. This is one of the smallest spring fish I have noticed in our fish-house. This scale shows exactly the same number of rings as those from a fish double the weight over the same period.

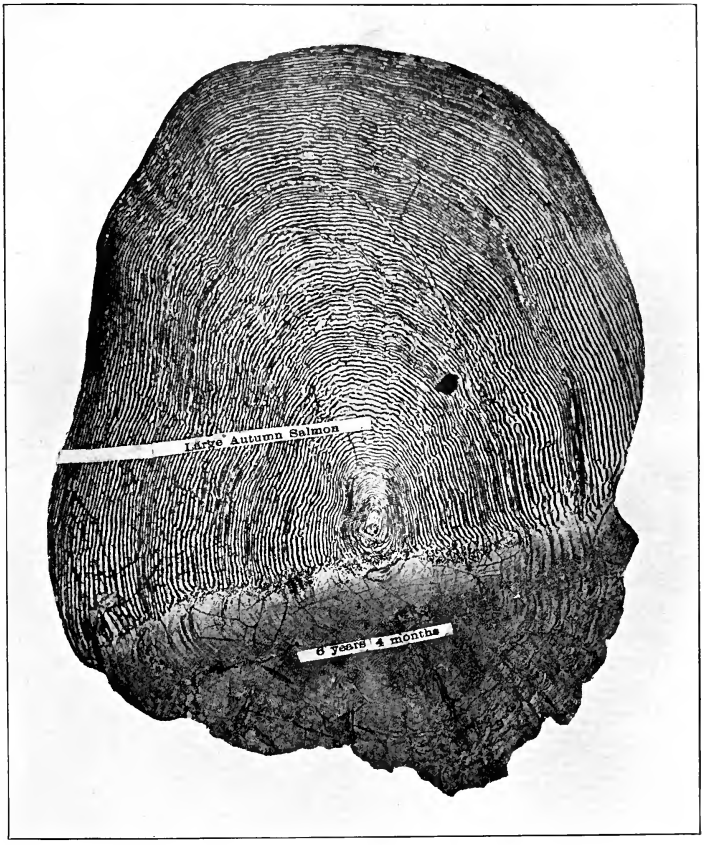


FIG. 92.—40 lbs. August 1906. First return from the sea.

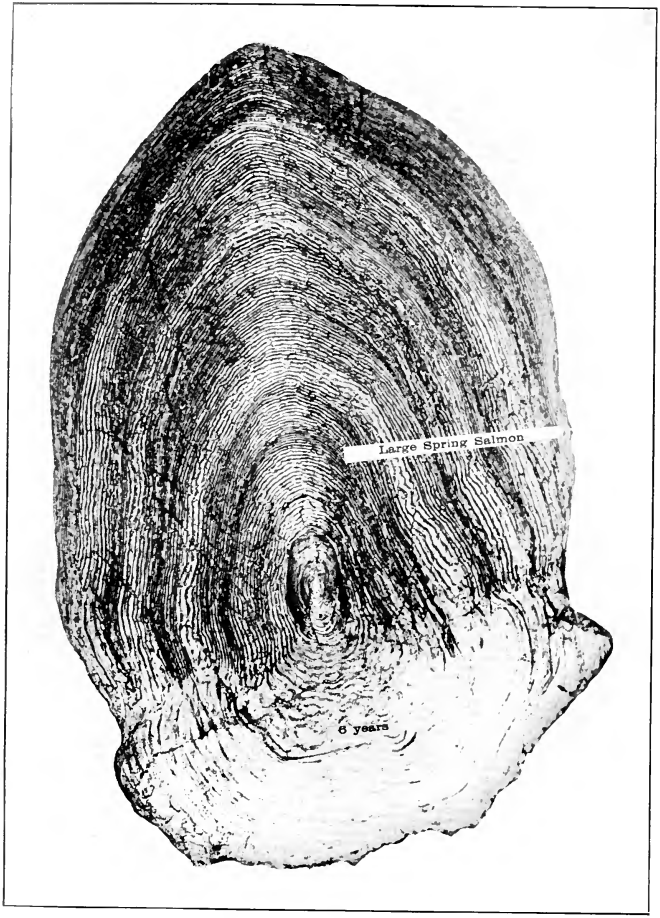


FIG. 93.—65 lbs. 6th June 1907. Norway.

Fig. 99 is a scale from another small spring fish, more than double the weight of Fig. 97, but having the same number of lines on its scale, denoting it has spent two years in fresh water and two years in the sea. Ten narrow lines can be discerned on the outer portion of the scale, and are known as the winter mark. The latter,

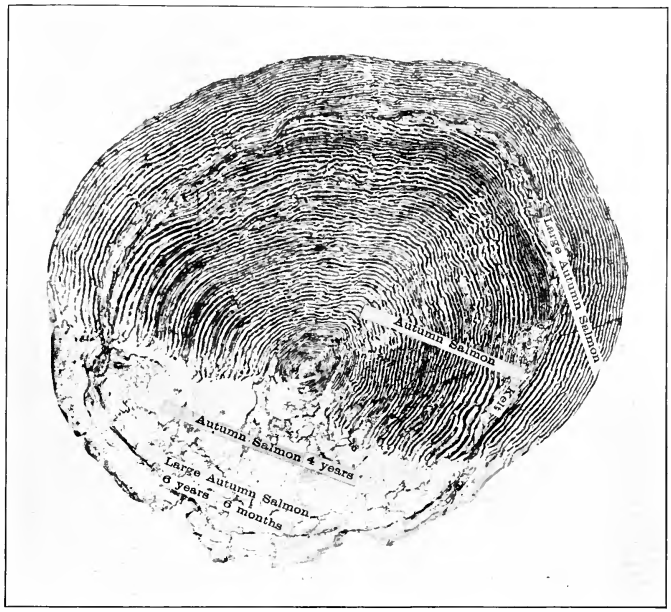


Fig. 94.—Marked as Kelt, 11 lbs., 12th February 1906. Recaptured clean, 26 lbs., 10th July 1907.

however, must have been added in the autumn, showing that this is not a reliable guide, as these marks are put on at various seasons.

The fish, Fig. 100, has been up on two occasions. On the outer margin of the scale eight lines can be clearly seen, showing that this fish had gone down as a kelt in the spring. From this contraction to the next ten rings can be counted, denoting it had done the same the

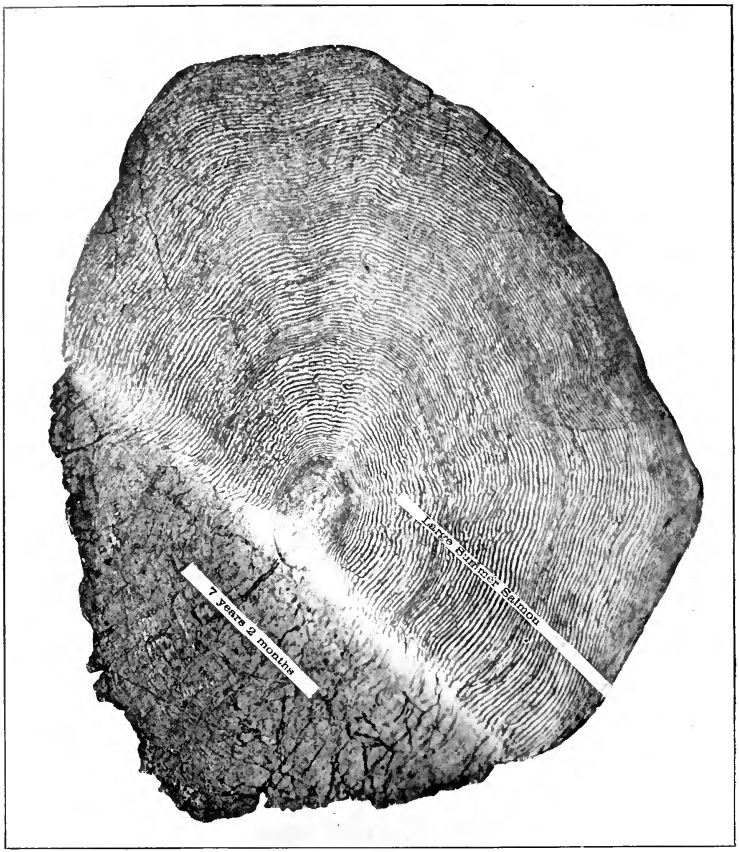


FIG. 95.—61 lbs. 13th July 1902. Tay. First return from the sea.

previous year. Had it escaped capture it would have ascended the river a third time, spawned, and become a kelt.

The scale, Fig. 101, is from a female fish, and has 118 lines. The parr stage shows twenty-eight lines; to this were added sixty lines before it came up in the autumn. Returning to the sea, it remained there for two years, when other thirty lines were added, making a total of 118 lines. If we add another ten lines for the time spent in fresh water (August to March) we get a grand total of 128 lines, making the fish to be eight years of age, which few attain.

FIG. 96.—14-lb. Male Salmon. 20th August 1911.

FIG. 97.—3½-lb. Small Spring Fish. 5th February 1911.

Fig. 102 is a scale from one of our marked fish of 12th February 1906. During the intervening dates twenty-three lines had been added to the scale, denoting a sojourn of seventeen months in the sea. This fish went down at the age of two years, having at that time thirty-two small lines on its scale.

The scale, Fig. 103, is taken from a fish marked as a kelt the previous year. From the outside to the kelt mark sixteen rings can be counted, which can be

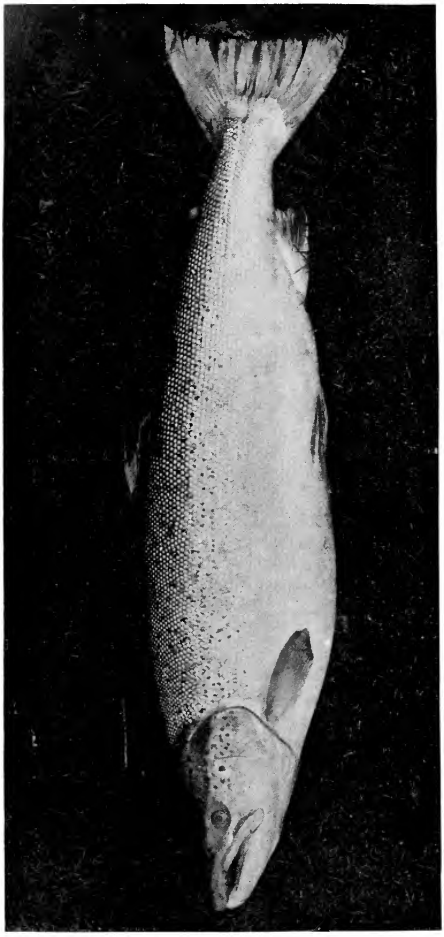


Fig. 98.—14-lb. Male Salmon. 20th August 1911. Second return from the sea.

taken as representing the number of rings put on by a fish each year. It is rather more difficult to count the rings from the centre outwards than vice versa, and for two reasons: (*a*) When a parr becomes a smolt rings are added outside the winter mark which are the same as those put on in the sea, and it is almost impossible to tell with certainty the last line added when in the river. This can be easily proved by confining a parr until it has reached the smolt stage. The above may also explain why a greater number of lines occur

Fig. 99.—7½-lb. Small Spring Fish. 22nd February 1911.

between the winter mark of the parr and the grilse than appear in after years. (*b*) The lines often break up into two or three parts, and are very difficult to follow. I always procure for examination scales having the greatest number of small lines in the parr stage, and as perfect in the centre as it is possible to get them. When I have selected a perfect specimen, I count from the centre to the right in an upward direction, but not quite to the top, because small lines are always forming there, which would confuse one. In this way, if one always counts in the same direction, one will find all the grilse, small spring fish and large spring fish, have the same number of rings. The

FIG. 100.—20 lbs. 20th August 1911.

FIG. 101.—35 lbs. 3rd April 1911.

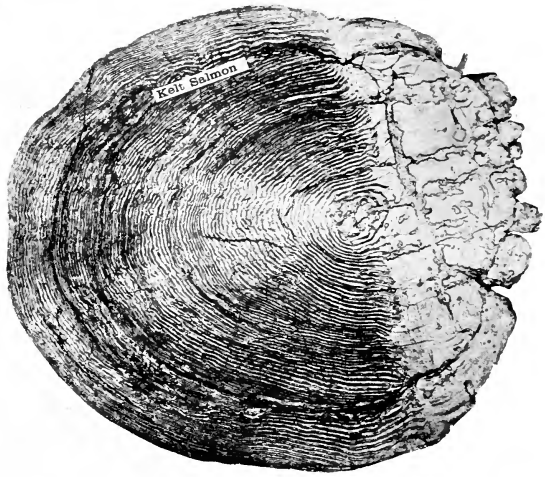


FIG. 103.—19 lbs. 8th March.

FIG. 102.—26 lbs. 10th July 1907.

lines from the kelt to their return in the clean state are quite easily counted, and give one a more correct idea of the number of lines put on in the sea during each month and year.

The fish, Fig. 104, has been in the sea one year and four months, having put on twenty-three lines on its scale since going down as a kelt. There are also eight very narrow lines where one would expect to find broad ones.

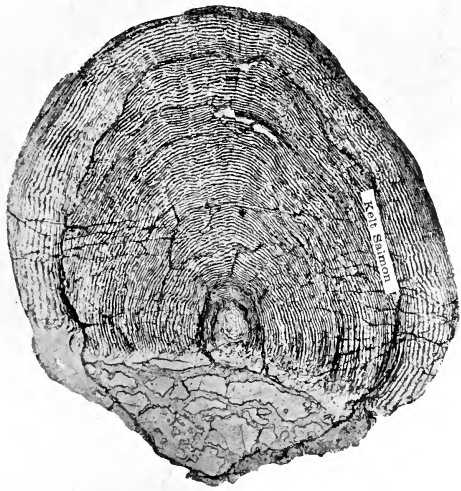


Fig. 104.—24 lbs. 20th June 1911.

The fish, Fig. 105, came up the previous year as an early grilse, spawned, became a kelt, and went down to the sea in spring, returning in July of the same year. There are eight lines from the kelt mark to the outer edge of the scale, showing it had gone down in February and remained six months in the sea. Many kelts which proceed seawards during winter and spring begin to return early in July, and increase in numbers daily until the advent of December,

FIG. 105.—7 lbs. 20th July 1907.

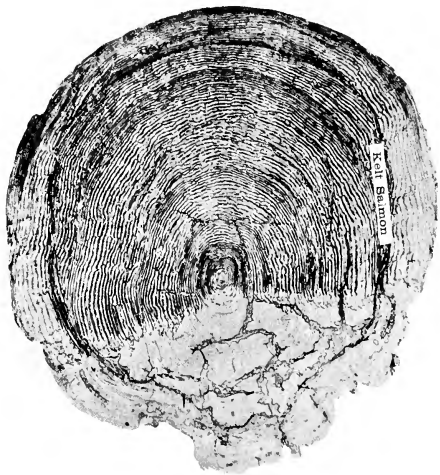


FIG. 106.—24 lbs. 11th April 1911.

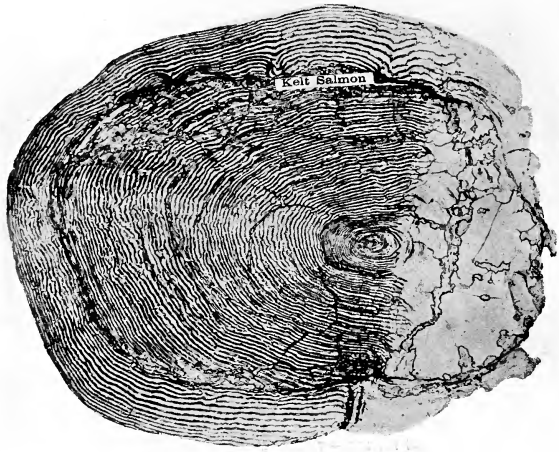


FIG. 108.—20 lbs. 11th April 1911.

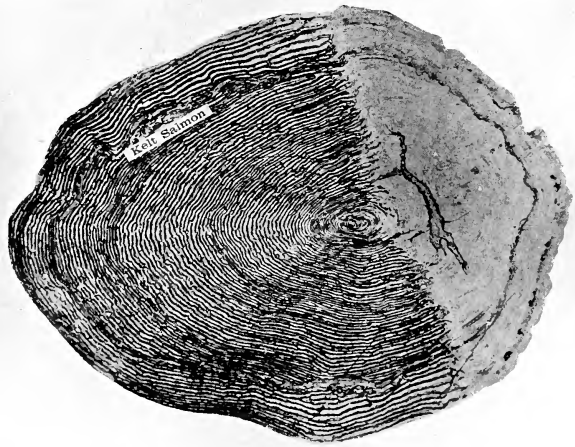


FIG. 107.—13 lbs. 11th April 1911.

particularly those that were kelts eighteen months previous to July.

A far greater number of fish return after spawning than is generally supposed; and our netting operations confirm this statement. When the netting ceases on the 20th of August we invariably come across the greatest number, and if the nets were to continue for four weeks longer we would meet with a much greater percentage.

FIG. 109.—35 lbs. 20th August 1910.

Fig. 106 is a scale showing sixteen rings added since descending as a kelt the previous spring.

Fig. 107 is a scale showing fifteen rings added since descending as a kelt the previous spring.

The fish, Fig. 108, has added sixteen rings to its scale since proceeding to the sea as a kelt the previous spring, and remained there throughout one year. The lines round the kelt mark have a peculiarly twisted appearance.

The fish, Fig. 109, has added twenty-seven rings to its scale

since descending the previous February, having spent eighteen months in the sea before again returning to fresh water. Before descending the scale shows a hundred lines, in addition to forty-two parr lines, quite the greatest number on any scale that I have examined from Tay salmon. I make this fish to have descended when three years old.

Salmon Scales from Norwegian Fish

It might be of interest to compare a few scales from fish of Norwegian rivers with those taken from our Tay fish. Col. Percy Hargreaves very kindly sent me some scales to examine (withholding name of river, date, and weight) from fish caught by him during season 1910. On examination I had little difficulty in detecting the time each had entered the river, its age, weight, and average weight of the whole, which I put down at 27 lbs. This proved to be within 3 oz. of the actual weight. Col. Percy Hargreaves' description of the river is as follows:—The Aaro in the Sognfield, near Sogndal, about seventy miles N.E. of Bergen, rises in a lake called the Hafsh Lake, and is about seven miles long. Salmon can only ascend for one mile, the other six miles being a series of waterfalls. The river for about six miles is nearly fifty yards wide, and is more like a mill-race than anything else. The lake is fed from a very large glacier, and from December to April the fishable part of the river is almost dry. As far as I can gather, nearly all the fish and burn-trout leave the river by December; a few may remain, but very few.

From a close examination of these Norwegian scales I have come to the conclusion that nearly all the parr become smolts when under two years of age. Most of the scales have on an average twenty-five lines on them before any change takes place, and on the larger fish this is clearly seen. On the other hand, all the smolt scales I have examined show more lines than are to be seen on those of the large fish. If I were to judge from the scales of the large fish when the smolts went down, I would say at twenty-one months, but judging from the smolt scales, I should say twenty-six months. No

doubt, the difference is due to the interval that occurs between the parr stage and the time the smolt goes to the sea. I have found the same difference to exist in the parr and smolts of the Tay. In my opinion, the large fish of the Aaro are of the same age as our spring fish in the Tay, which average 22 lbs., the difference being due to the fish of the former having four months' longer feeding in the sea. Out

FIG. 110.—22-lb. Female. Norway, 9th June 1910.

of forty-eight scales examined, I found thirty-eight to have an average of eighty-four lines on them, the remaining ten having over one hundred lines, showing they had been up on a previous occasion. Apparently no run of small spring fish takes place in this river. The larger fish make their appearance towards the end of May, followed by a run of smaller fish, averaging about 16 lbs., early in July, and in August by a few grilse and sea-trout.

The scale taken from the fish, Fig. 110, has eighty-four lines on

FIG. 112.—23-lb. Female. 26th June 1910.

FIG. 111.—32-lb. Female. 12th June 1910.

it, making its age to be five years three months. Thirty narrow lines point to its having gone down when two years old.

The scale, Fig. 111, shows one hundred lines, and the fish went down as a kelt the previous year, when it put on sixteen lines. Thirty narrow lines in the centre show it had gone down also when two years old.

The scale, Fig. 112, shows eighty-five lines, making the fish to

Fig. 113.—29-lb. Female. 28th June 1910.

be five years three months. It is impossible from this scale to tell where the parr lines end, as they are not well defined.

The scale, Fig. 113, shows eighty-seven lines, making the fish to be of same age as Fig. 112. The parr lines in this scale are well defined, showing clearly each year's growth of sixteen lines. This fish went down when two years old.

The scale, Fig. 114, shows thirty parr lines, showing it had gone down when two years old. At four years and three months it came up again, the rings having increased to sixty-eight. The fish then

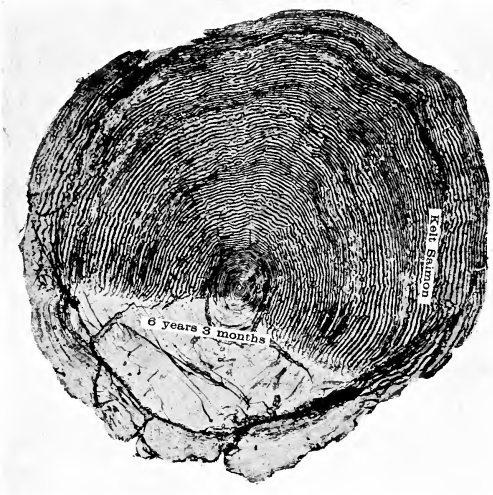


FIG. 114.—36-lb. Male. 29th June 1910.

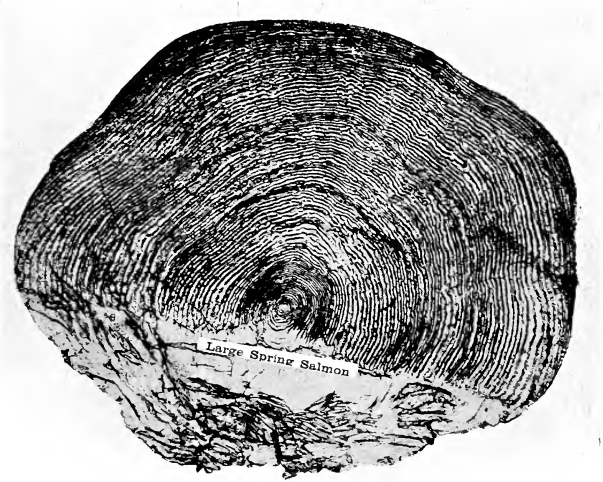


FIG. 115.—24-lb. Male. 30th June 1910.

became a kelt, descended, and came up the following year, adding sixteen additional rings, making it six years three months.

Fig. 115 is a scale showing one hundred and two rings. There are two well-defined contractions, each of which has sixteen lines, showing it had also gone down when two years old, making it in all one month older than Fig. 114.

Fig. 116.—35-lb. Female. 6th July 1910.

I can only make out eighty-four lines in the scale, Fig. 116, as the centre part is incomplete. This fish is on its third return, having been up on two previous occasions. There are sixteen lines between the last two contractions.

The scale, Fig. 117, shows eighty-five lines, making it out to be five years four months. It shows twenty-three parr lines, but it is impossible to know when it went down—probably when two years old.

FIG. 117.—25-lb. Female. 11th July 1910.

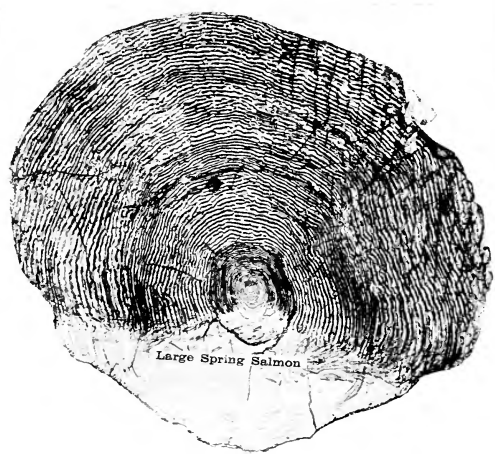


FIG. 118.—22-lb. Male. 9th June 1910.

The scale, Fig. 118, shows thirty-two parr lines, sixteen between each contraction. It is quite an interesting scale, as at the second contraction one can discern a distinct line encircling the scale, such as is made when a fish is on its second return from the sea. This ring might be caused after spawning, when in the kelt stage, by the scale becoming reduced. We know quite well male parr spawn and become kelts, but we do not know if the same thing happens with the kelt-parr as happens with the salmon on its second return. With the

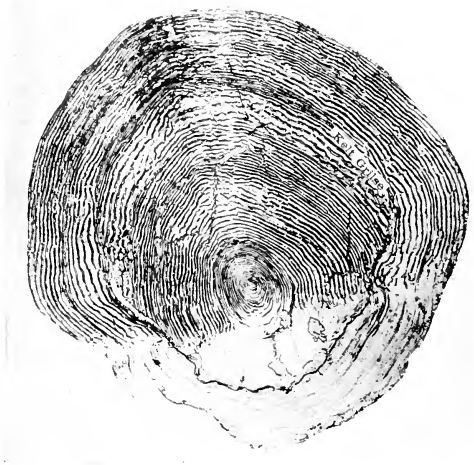


FIG. 119.—14-lb. Male (Namsen). 7th June 1911.

former, however, the ring is put on in fresh water, and in the case of the latter this occurs in the sea. Many male parr during the second season have a more pronounced and better-defined ring on their scales than is to be seen in that of the opposite sex. When we state a fish has only spawned once, we may not be quite correct in our assumption, for in the parr stage spawning may have occurred two or three times. In the case of the opposite sex, however, we are more sure of our ground, as we never find female parr carrying spawn.

During 1911 I examined several parr sent me by Col. Percy Hargreaves from the Aaro, and I found the following number of lines on their scales: $5\frac{3}{4}$-inch parr with fifteen lines; $6\frac{3}{4}$-inch with twenty-six lines; and 8-inch with thirty lines.

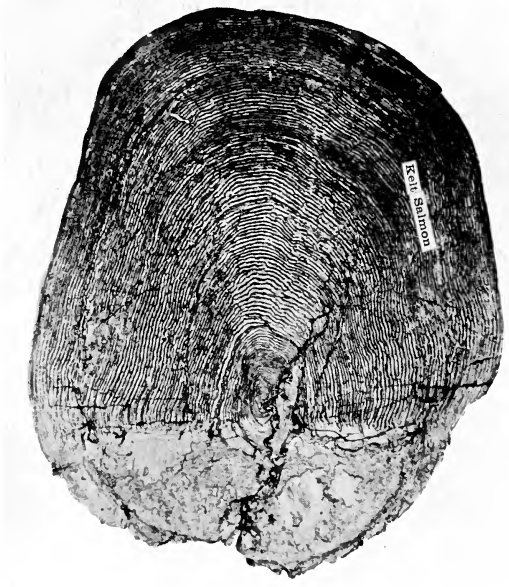


Fig. 120.—35-lb. Female (Namsen). 12th May 1911.

Norwegian Scales (River Namsen)

I am indebted to Henry J. Pearson, Esq., Bramcote, Notts., for scales taken from River Namsen fish.

The scale, Fig. 119, has in all seventy-five rings, twenty-three of which are narrow ones, showing the fish had gone down when two years old, or perhaps a month or so earlier. It came up as a grilse,

went down again to the sea, and returned the following year, and during that time added nineteen rings.

The scale, Fig. 120, has twenty-five narrow lines, which also shows it had gone down when two years old. When six and a half years of age it returned again, having at that time one hundred and five rings. Going down again to the sea, it returned the following year with seventeen rings added to the scale.

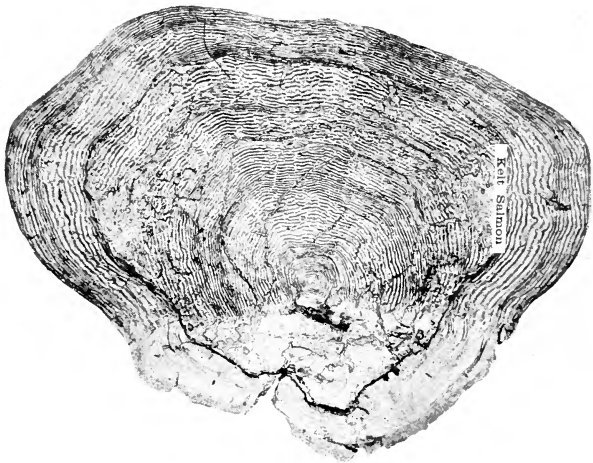


Fig. 121.—27-lb. Male (Namsen). 12th June 1911.

The scale, Fig. 121, has twenty-seven small rings, showing it had, like the preceding two, gone down when two years old. During its stay in the sea other sixty-three lines were added before again coming into fresh water. Once more descending, it came back the following year showing twenty additional lines on its scale.

The scale, Fig. 122, shows one hundred and twenty lines, of which twenty-five are parr lines. During its first sojourn in the sea

Fig. 122.—38-lb. Female (Namsen). 17th June 1911.

Fig. 123.—36-lb. Male (Namsen). 17th June 1911.

seventy-six lines were added, and on its second visit twenty-one lines, making the fish to be $8\frac{1}{3}$ years of age.

The scale, Fig. 123, has one hundred rings, twenty-five of which are parr lines. This fish is on its first return from the sea, and is $6\frac{1}{4}$ years of age.

I examined other six scales, and found all to have the same

Fig. 124.—62-lb. King Salmon.

number of lines, namely, one hundred and thirty-seven. Strange to say, out of ten scales, I found four of them to have been up before, and this in a river where anglers seldom meet with kelts. From this it is clear more kelts must go down and return than is generally believed to be the case. In order to arrive at a correct idea how many return, the river would require to be netted each month from May to October, so that a much larger number could be examined.

John Roberts, Esq., very kindly sent me several scales taken

from fish caught in the Fusta River, Norway. The scale from a 35-lb. fish had one hundred and one lines, twenty-seven of which were parr lines. I make this fish out to be $6\frac{1}{4}$ years old. Another scale from a grilse showed fifty-three lines, and was quite like one of our own from a Tay fish. Mr. Roberts was also kind enough to get his ghillie to send me a few parr from that river. Those I examined had all nineteen lines on their scales, and were caught in August. No

Fig. 125.—35-lb. Tyee Salmon (Campbell River). 20th August 1910.

doubt, if caught in May of the following year, the usual number of lines would be found.

Scales from King or Tyee Salmon, Campbell River, Vancouver

The illustration shown (Fig. 124) is from a scale kindly sent me by R. P. Page, Esq. This scale has one hundred and twenty-eight lines, and estimating its age as we do the salmon, I would say it was

8 years old. The lines on this scale are very well defined, and show no parr mark or contraction.

I received the scale, Fig. 125, from Captain B. Starkey. There are eighty-eight lines on this scale, which compares favourably with those of Tay salmon of the same weight, whose age would be $5\frac{1}{2}$ years.

Like the former salmon scales I found no parr marks or contractions. Fig. 126 has seventy-eight rings, and another I examined

Fig. 126.—14-lb. Choe Salmon (Vancouver). 4th September 1910.

from a fish of 8 lbs. had seventy rings. The former, I presume would be $4\frac{1}{2}$ years and the latter 5 years of age.

Large Salmon

The largest salmon caught in British waters during the last thirty-six years was caught in the nets on the Tay at Newburgh in 1872. Its length was 4 feet 5 inches, its girth 2 feet 7 inches, and its weight 71 lbs. Mr. Frank Buckland had a cast made of this fish and painted by Rolfe. It is now in the Buckland Museum, South Kensington, labelled 70 lbs., having evidently lost 1 lb. by the time it reached London, as

I distinctly remember seeing it in Mr. Speedie's window in Perth, labelled 71 lbs. I was fortunate in procuring the negative of this fish, and have pleasure in reproducing it (Fig. 127). Fish between 50 and 60 lbs. in weight are often caught in the nets on the Tay, while a few between 60 and 65 lbs. are sometimes captured; but beyond this weight fish are rare. I have noticed in our fish-house as many as forty fish over 40 lbs. in weight, all caught in one day with the nets. In smaller rivers, however, a 40-lb. fish is considered a monster. The following are the weights of a few of the largest fish caught with the rod on the Tay:—

Date.	Weight.	Name of Angler.	Where Caught.	How Caught.
March 1870	61 lbs.	John Haggart	Stanley	Minnow
July 1875	51½ ,,	J. Gellatly	Ballathie	Sea-trout fly
Oct. 1883	54 ,,	Lord Ruthven	Taymount	Fly, Jock Scott
	55 ,,	The Marquis of Zetland	Stanley	Fly, Major
Oct. 1898	56 ,,	Captain Goodwin	Scone Palace water	Prawn
	53 ,,	Lord Blythswood	Stobhall	Fly
Oct. 1903	55½ ,,	P. M. Coats	Stobhall	Fly, Wilkinson
,, 1903	47 ,,	W. H. Coats	Stobhall	Fly
	51 ,,	Mr. Fletcher (Manchester)	Below Perth—free water	Minnow
Oct. 1907	63 ,,	Mr. Stewart (Perth)	Below Perth—free water	Worm

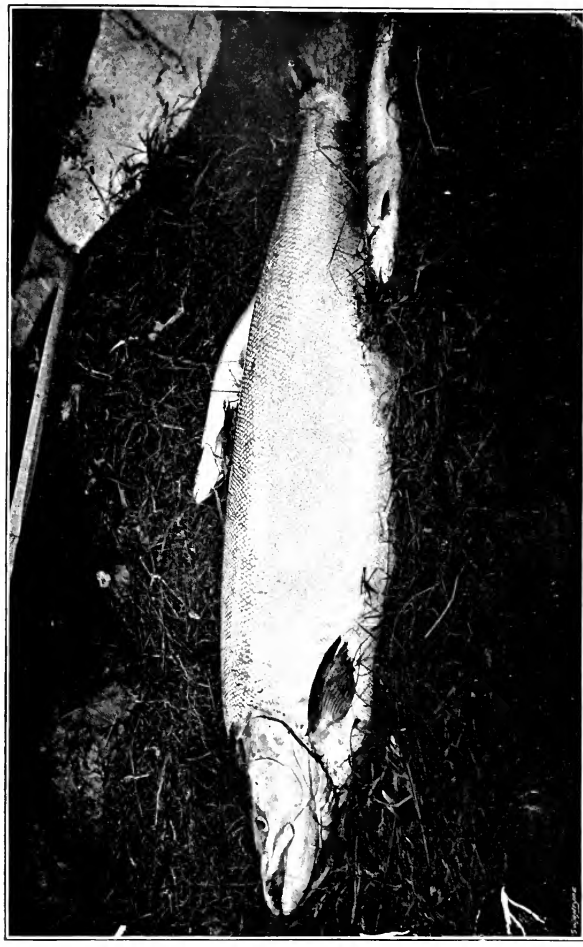


FIG. 127.—71-lb. Salmon, caught in the Tay, 21st June 1870. Length, 52 in.; girth, 32 in.

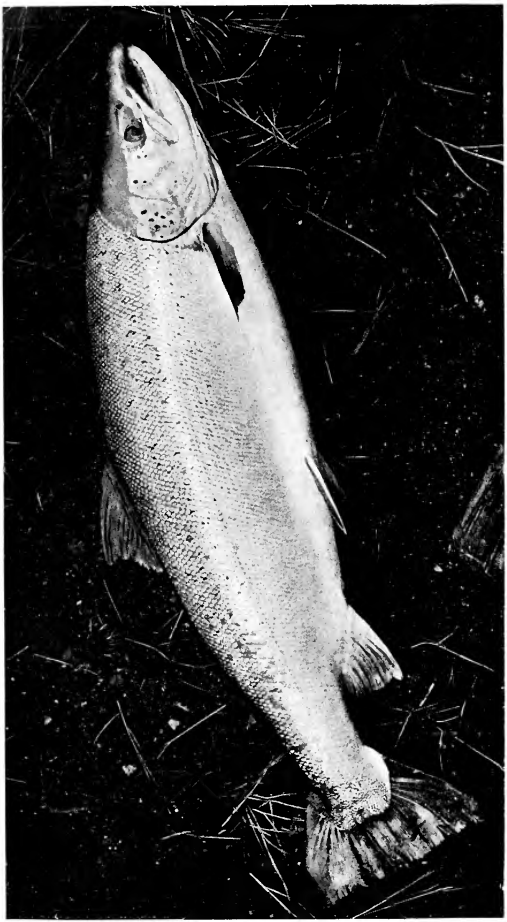


FIG. 128.—57½-lb. Male Salmon. 4 ft. 5½ in. long; 2 ft. 4½ in. girth. The Tay, 24th May 1907.
See scale, Fig. 86.

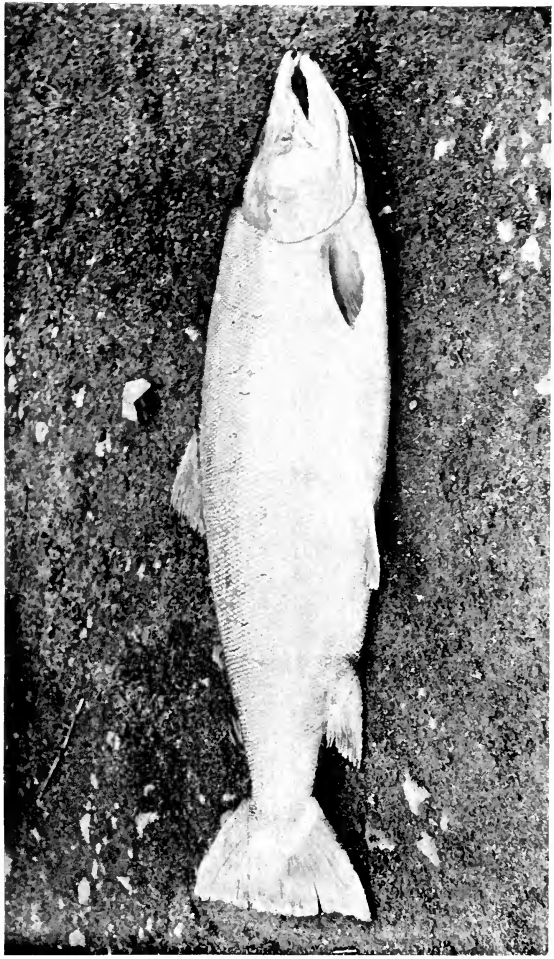


FIG. 129.—52-lb. Male Salmon. The Tay, June 1907. First return from the sea.

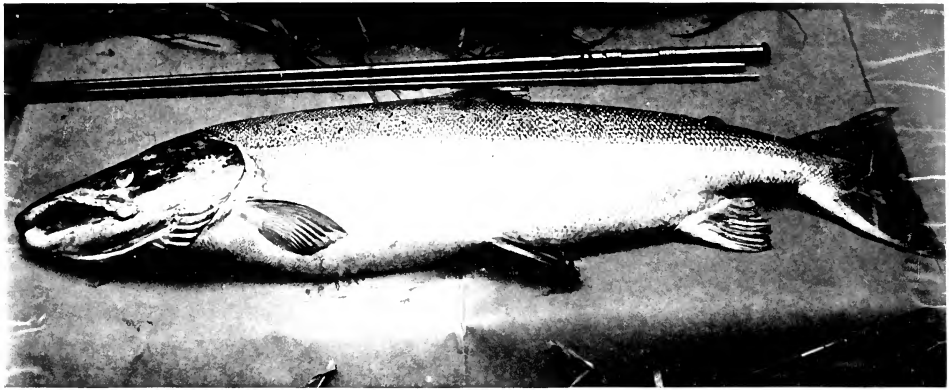


FIG. 130.—53-lb. Male Salmon, caught with fly by the late Lord Blythswood. The Tay, October.

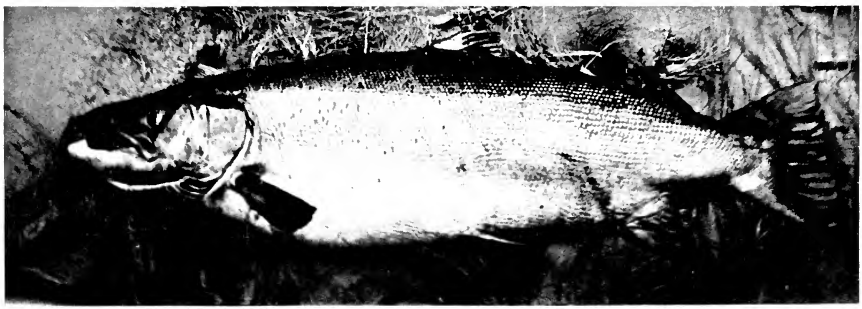


FIG. 131.—55-lb. Male Salmon, caught with prawn by Captain Goodwin. October 1904.

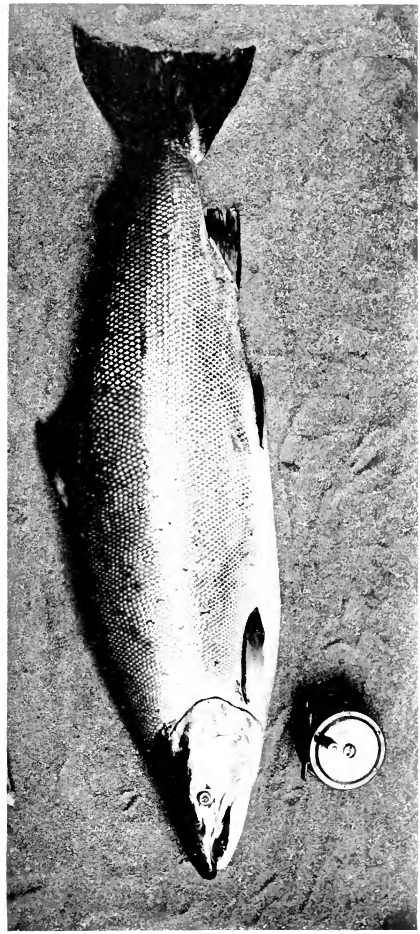


FIG. 132.—44-lb. Male Shannon Salmon. May 1902.

FIG. 133.—47-lb. Male Salmon, caught with fly by the late Lord Blythswood. October 1903.

Fig. 134 shows the head of the 63-lb. fish caught in October 1907 (see p. 120). It weighed 23 lbs., and the length from snout to gill-cover measured 15 inches. The average weight of the heaviest salmon taken with the nets each year on the Tay for fourteen years is 60 lbs. 2 oz. The largest fish taken in the nets this year (1908) was 63½ lbs.

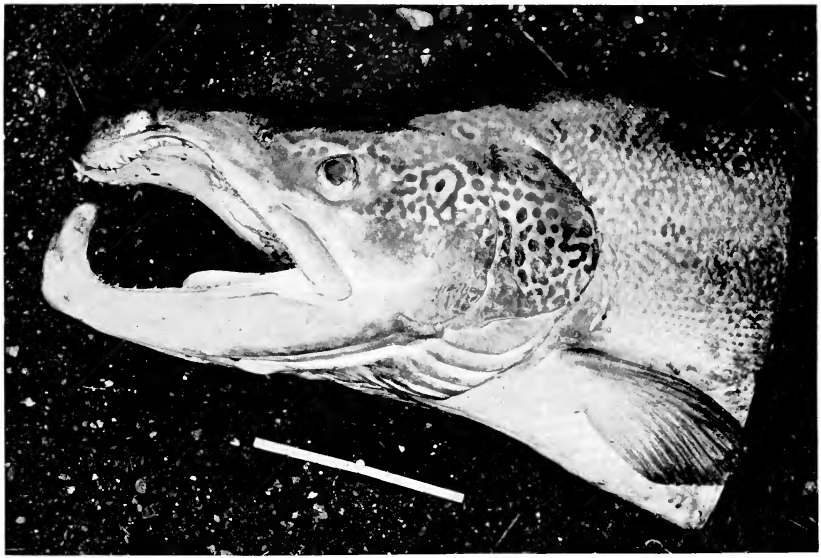


FIG. 134.—Head of a 63-lb. Male Salmon, caught by the rod on the Tay, October 1907

SALMON BRED IN PONDS AND CONFINED IN LOCHS

Parr hand-fed in ponds differ widely from those bred in their natural state. If they are specially well fed, many of them will become smolts at the age of one year. When this happens the smolt goes on feeding and growing far more quickly than his neighbours in the same pond that are still parr, and will not cease feeding during the winter if food is abundant. When the Stormontfield Ponds were emptied on 23rd March 1908, it was found that something had

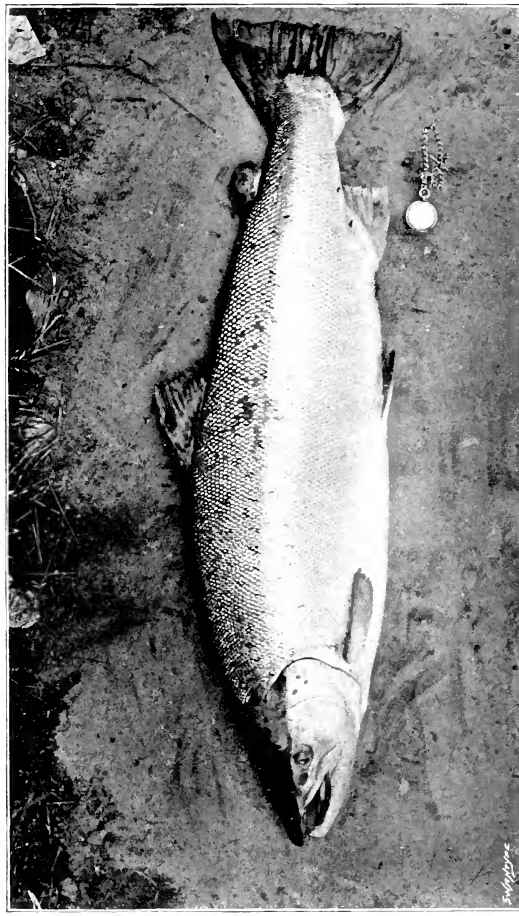


FIG. 135.—58-lb. Tay Male Salmon. June.

FIG. 136.—47-lb. Tay Male Salmon, caught by the late Lord Cairns.

happened to the fry, with the result that the numbers of smolts and parr were greatly reduced. Those remaining had more feeding than usual, consequently a greater proportion became smolts the first year, many of them being eight times the weight of those that remained parr. Fig. 139 shows two of the same age—the one 8 oz., and the other 1 oz. The larger one became a smolt when one year old, and the smaller was just assuming the smolt stage when two years old. The larger one, too, had a greater number of rings on its scales than the other. If these smolts are prevented from going to the sea, they develop ova and may spawn on more than one occasion, but their growth is greatly retarded. A smolt thus imprisoned usually weighs at the end of the first year from 6 to 10 oz.; at the end of the second, from 10 to 18 oz.; and at the end of the third year, from 18 to 32 oz. A smolt four years old can thus be 2 lbs. in weight if it has remained all its time in fresh water. (See illustrations of smolts at different ages and of different weights.) Smolts so confined become very restless, moving rapidly through the water and leaping high into the air. Several I had con-

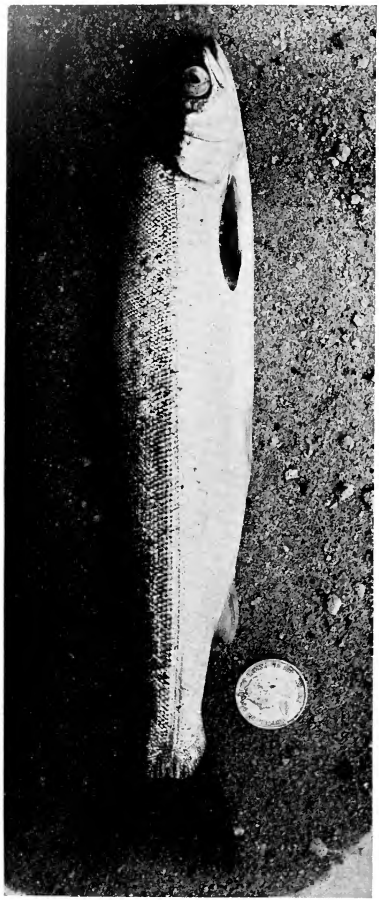


FIG. 137.—6-oz. Smolt, confined in Bertha Loch six months after becoming a smolt. September 1905.

fined in tanks succeeded in jumping out, whilst others merely swam round and round as if seeking for an exit. Should such be made in a pond, or even in a large loch, smolts would quickly find it out and make their way seawards.

After a parr becomes a smolt it never loses its silvery scales again. All those I have ever caught were like a bar of silver both in summer and in winter. During April and May they rise freely to fly, but after this they begin to become bottom-feeders. When hooked with fly they give good sport, cutting through the water like a knife, and then jumping several times out of it.

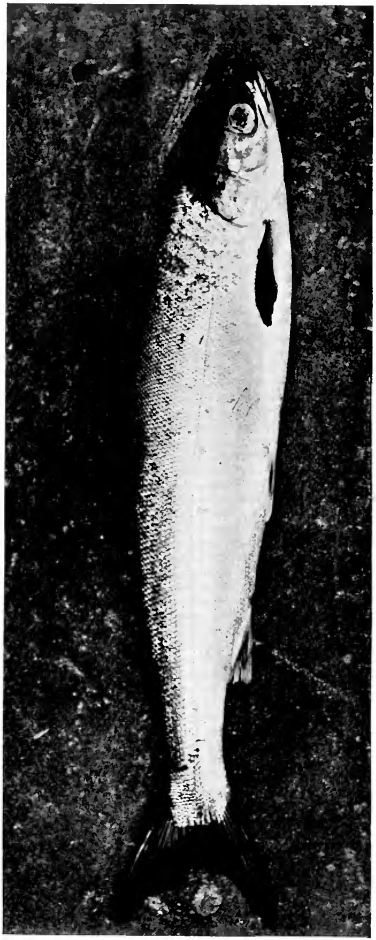


Fig. 138.—4-oz. Smolt, confined in Bertha Loch five months after becoming a smolt. August 1907.

Salmon Feeding in Fresh Water

A great deal of nonsense has been talked about salmon feeding in fresh water. I have had ample opportunity of watching salmon all my life, from the time they enter fresh water till their return to the sea, and I have given close attention to the subject, and have no hesitation in stating that during the salmon's sojourn in fresh water it does not require to feed. It does seem strange, of course, that a fish coming up a river in

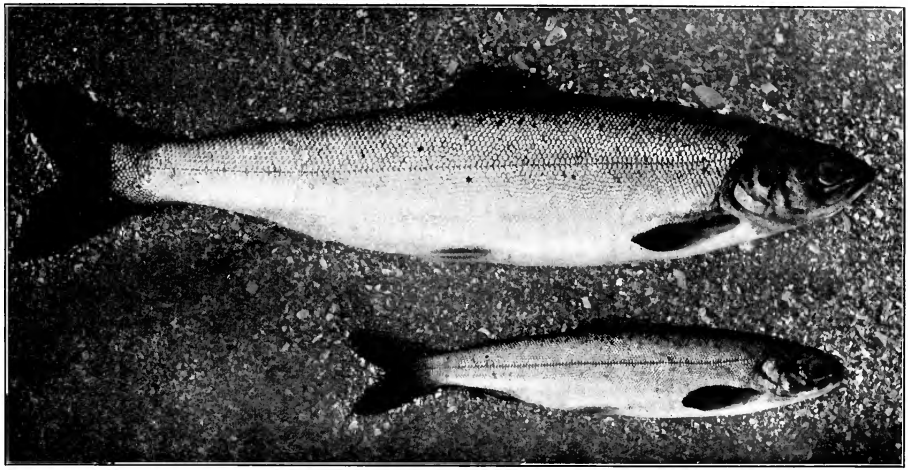


FIG. 139.—8-oz. large Smolt, two years old, confined in Stormontfield Ponds a year after becoming a smolt. Small one, 1½-oz. Smolt, two years old.

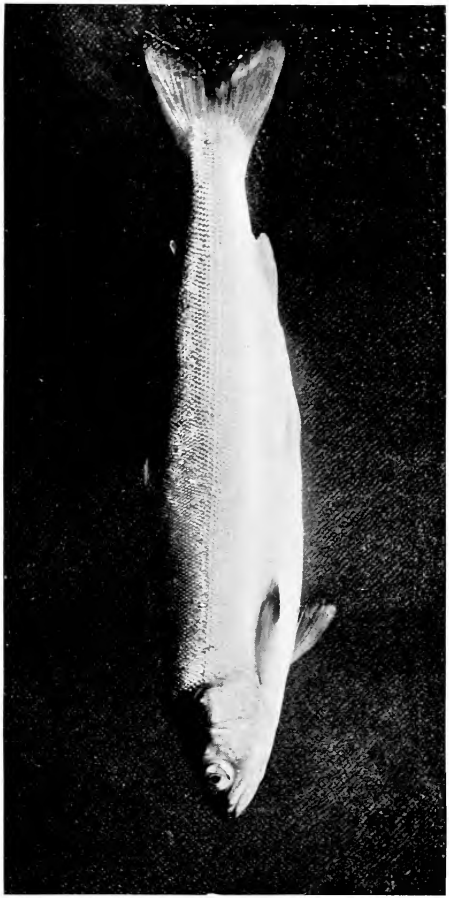


FIG. 140.—12-oz. Smolt, confined one year after becoming a smolt. May 1905.

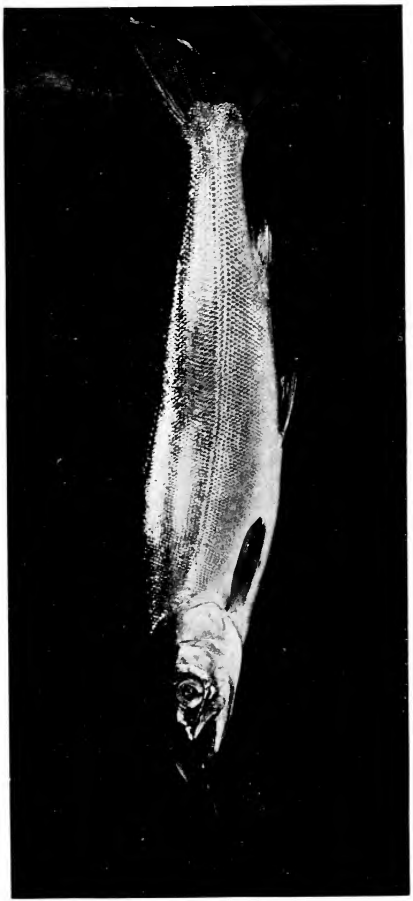
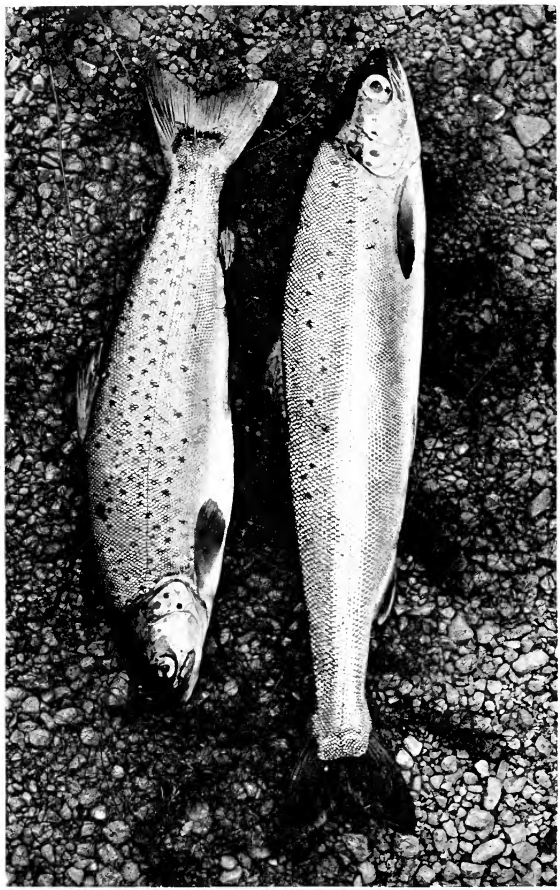


FIG. 141.—8-oz. Smolt, confined in Bertha Loch fourteen months after becoming a smolt. 1st July 1905.

FIG. 142.—12·0z. Smolt, confined in Bertha Loch fifteen months after becoming a smolt. July 1924.

October in prime condition, remains there for seventeen months, and returns to the sea without having tasted food; nevertheless, it



(1) (2)

Fig. 143.—(1) 8-oz. Loch Dupplin Trout.
(2) 12-oz. Smolt, confined in Loch Dupplin sixteen months after becoming a smolt. August 1904.

is true. Many people do not believe this, and no doubt there will be a considerable number of that opinion for many years to come.

When fish enter fresh water they begin to decrease in weight, and altogether fall off in condition until they return to the sea again.

FIG. 144.—2-lb. Smolt, confined in reservoir two years after becoming a smolt.

Others again endeavour to prove that they do feed in fresh water by referring to the well-mended kelt; but, although the kelt appears as

if it had been feeding and growing fatter, it is still losing weight. It is not, therefore, the fish that is growing fatter; it is the eye that is deceived by the scales becoming more silvery and the fish more showy. The kelt, of course, does become much stronger in April, and is then more difficult to land; but the same thing holds good with regard to spring fish, for in the cold weather in January and February they are not nearly so strong as they would be if caught in April or May. It is the higher temperature of the water that is the cause of this: it is not that the fish has become stronger through feeding. No doubt a fish immediately after its exertions in spawning is weaker than it would be, say, two months later, but its strength is due to good health and not to feeding. In all my experience I have never observed a kelt chase a parr, smolt, or trout, nor have I ever known of any one having seen such a thing, although I quite recently read an article in which the writer mentions that kelts make great havoc amongst smolts! If salmon do feed in fresh water there would be nothing but parr, smolts, and trout for them to feed upon. If such were their food, then the hundreds of thousands of salmon in some of our rivers would swallow them all up in a week. They will take a cherry, a gooseberry, an acorn, a leaf, or almost anything that swims against the current. On taking any of these, however, the fish eject them even although they have been swallowed, and allow them to fall to the bottom without exciting any further curiosity.

I have on several occasions dropped prawn from a bridge into a river. They were readily taken, but after a few nibbles the fish allowed them to fall to the bottom. I have dropped sweets in the same way, and the fish took them, but treated them as they did the prawn. A few years ago, for the sake of experiment, I obtained leave to kill as many kelts as I wished during the last week of April, at which period the river is full of smolts. I killed many of them, but failed to find any food in their stomachs. At the same time I killed many sea-trout kelts, weighing, in some cases, 3 and 4 lbs. In most of these, however, I found flies and the larvæ

of the early Ephemeræ and caddis-flies in process of digestion. I have examined thousands of salmon in our fish-house, but have never found any trace of food in any of them; neither have our men, who have had hundreds of thousands through their hands. As I have already said, it is not so with sea-trout and brown trout. They are often found gorged with parr and smolts. In the stomachs of sea-trout caught in tidal waters are often found sand-eels, sparling, and young herring.

"Why do Fish come up from the Sea?"

The majority of anglers and those interested in the life-history of the salmon would undoubtedly answer "To spawn."

This may be one reason, but I am not convinced that it is the true solution. If we but consider, a spring fish coming up in October, with no signs of spawn developing, and remaining in fresh water for more than a year before spawning, it is difficult to believe "the spawning instinct" has caused it to leave the sea. My own idea is (and I am pleased to note Sir Herbert Maxwell holds the same views) the fish feed in the sea so long as they are able, and then when the migratory instinct comes on they make for their own particular river. They may remain for a longer or a shorter period in the river, but the desire to feed does not again return until they have spawned and become kelts. Even in the kelt stage no undue haste is apparent of their desire to return to the sea to feed. I do not for one moment believe that fish coming up a river return again to the sea to feed before finally entering the fresh water to spawn. We occasionally meet with fish in the Tay estuary, mostly red fish which have come up in the spring, but these are so few in number we could scarcely call it a migration. Another point requiring to be cleared up is—Why do some fish re-enter a river after one year's sojourn in the sea, whilst others are two, three, and four years before returning?

It is also difficult to find a satisfactory reason why some kelts, after a four months' sojourn in the sea, return to the river, whilst others remain from one to three years. Parr, as we know, go from

feeding during the winter, and nature may work in the same mysterious way with the salmon during each succeeding winter in the sea.

This periodic temporary fast, as we might term it, may account for the closer dark lines that appear on the scales. I do not, however, think this could be caused by the fish ceasing to feed, as they cease doing so at all seasons when their time comes to enter fresh water. We see this in trout, but not quite so pronounced. In Loch Leven during the summer and winter about six per cent of the trout are barren, and would not spawn the same year. These trout keep in perfect condition during the winter and summer, and do not seek up the various spawning streams. Fish may, therefore, come up from the sea for two reasons: (1) Feeding has ceased; (2) Forced to do so because spawning season has arrived. We know from the marks on the scales that many of the autumn fish full of spawn feed up till the time they leave the sea. This may have something to do with the kelts from these fish returning quickly to the sea after spawning. All autumn fish, however, do not behave in this manner, as many remain for a much longer period after spawning.

Movements of Salmon in Tidal Rivers

My experience of the movements of salmon in tidal waters is almost entirely confined to the Tay. The Tay has a long estuary, and the tide flows for a distance of 35 miles. The lower part of the river is from 2 to 3 miles broad during high water, and the upper part from 100 to 400 yards wide. During winter and spring many fish remain a considerable time in the estuary on coming from the sea. It is rather strange that an east wind brings the fish in towards the shore, whilst a west wind makes them hasten up the river. Mild weather, too, makes them push up the river, while snow floods keep them back. When the snow water begins to leave the river they come on in large numbers, and during some seasons it is only when the floods cease that the fish begin to run, although, when the floods are caused by rain, fish will run in high

water. As the season advances the fish are more inclined to come on, and the greater number of them come up the estuary with the tide. At high tide, however, many fish turn and go down the river on days most suitable for their travelling upstream.

Taking the season as a whole, more fish are caught with the nets on their way down the river than there are on their way up. From May until the end of July fish coming up with the tide are far more eager to push forward than those ascending at any other part of the season, very few remaining in tidal water during summer. In the early autumn, however, large numbers of fish coming up with the tide, return to the estuary again, and remain there until the temperature of the weather or the water induces them to push forward. Both high winds and floods induce fish to move upstream. During August and September floods need not be higher than from four to six feet to bring them off the banks below. While they remain in the lower parts of the river they lose their silvery appearance, become red in colour, and show signs of the spawning season coming on them. Often when fish are running well in a moderate-sized flood, and the river continues to rise, they will cease running for the time being, or, in the words of the fishermen, the high water "puts them back." The largest number run when the river clears up, one day or, it may be, two days after the flood.

Throughout spring most of our fish are caught on the sunny side of the river, showing that they keep to this side. In the autumn, again, they are got on both sides. I am inclined to think that fish coming in from the sea, run up with the tide and fall back again as it ebbs, and do not proceed up the river again until wind and water are favourable for their pushing right forward. If this were not so, I am afraid they would have little chance of escaping the nets, for on four occasions during twenty-four hours and twenty-four times a week they would run the risk of being caught. As a rule, when fish are collecting in the estuary, it is chiefly the ones that have just come from the sea that are caught by the nets, and very few red ones. The latter, however, are captured when a flood comes and they begin to leave the banks. When everything is favourable for fish running, the best

conditioned ones are to be met with. On days that are unsuitable for running, many of the fish are thin, and a greater number in proportion are seal-marked, showing that fish in prime condition are more inclined to run when the water and weather are suitable. More fish run during night than during the day.

The Movements of the Fish in the Sea

We have little knowledge of their movements from the time they visit the sea as smolts until they appear again along the coast, and are either caught in the stake-nets or soon after they enter a river. I am of opinion that every salmon or grilse on coming to our shores wishes to enter its own river, and would do so if it were not caught in these nets. A good deal of nonsensical talk has been indulged in, in arguing the advisability of catching all the fish in the sea and leaving the rivers unfished. The wiser plan, however, would be to remove all stake and bag nets from the sea and catch the fish in the rivers. They can be caught in the rivers at far less expense, and being caught by sweep-nets, are not so roughly handled, and are killed at once on being captured. They are thus in much better condition than those caught in stake-nets, although I know many people think differently.

During the sitting of the recent Royal Commission, Lord Elgin was astonished to hear me say that the fish caught in our sweep-nets were better than those caught in our stake-nets in the sea. My explanation was, the method of catching them made the river ones superior to those caught in the sea. If they toss about in the stake-net until they die and are then rolled about by the waves, their scales are torn and rubbed off and their flesh becomes soft and flabby, and altogether they have the appearance of "cadged" fish. One can easily see this if the two kinds be compared on a fishmonger's slab. The sea-caught ones lie as flat as a flounder; whereas the river-caught ones are stiff and rigid and do not lie flat.

I am of opinion that the increased number of stake and bag nets on the coast is not only curtailing the supply of fish, but is actually

ruining some of our West Coast rivers which used to swarm with salmon, but whose yield at the present time is almost nil. The fish run up these small rivers from the sea in time of flood; but when the flood subsides there is not enough water to protect them, consequently they are forced to return to the sea again, and are captured by the stake-nets, so that few are left to ascend the river and maintain a sufficient stock. Wherever, too, stake or bag nets have been removed the stock of fish has increased. At present these nets are allowed to be used far too near the mouths of rivers. In my opinion they ought to be at least two miles away.

Some people maintain that they catch many fish that would not enter a river the same season, but most of the fish that come to our coasts are steering their course to some river. I do not think more than three per cent of the salmon thus caught would remain in the sea. Even if many of them did remain, it is no argument in favour of catching them in the sea, because the nets would be taking immature fish, which by another year might be three times the weight. Again, during their sojourn in the sea their food costs nothing. I think, then, the number of stake-nets in the sea should be greatly lessened. Riparian proprietors spend a great deal of money in providing for the welfare of the salmon in their rivers. Yet we find fish so reared are caught by others living outside of the river district, and in a wholesale manner by stake-nets, causing the rivers to become neglected, and the supply of fish to become very limited. So long as plenty of fish are allowed to pass into the rivers, they will be protected whenever they show signs of increase. About thirty years ago many proprietors would say to me that their stretch of river brought them so little return that they were not troubling to look after it. Since then, however, their stretches have risen in value to the extent of 300 or 400 per cent.

The Salmon Disease

The salmon disease first made its appearance in the river Eden at Carlisle; the following year it was noticed in the Tweed; and the

next year in the Tay. No one has yet been able to find out its cause, nor to devise a remedy for it. I do not pretend to know anything

Fig. 145.—Live Salmon (*Sc*) with disease, under shade of a tree. December 1903.

about its cause or cure, but I have seen a great deal of it in the Tay and its tributaries, which have never been free from it since its

introduction. During some seasons it is worse than in others, and the colder the weather the worse it becomes.

In the year it was first known it commenced in the spring by attacking spring fish. In the autumn, again, its ravages commenced in September, and continued during the whole winter, causing the death of thousands of fish. Since then the autumn fish have become affected later each year, and this year (1907) very little of the disease was seen among the autumn fish until December. Winter, spring, and summer fish, however, are more or less affected throughout the whole year when they enter the higher reaches. This, I think, is caused by the clean fish entering the district where the river is full of old diseased fish. If so, these spring fish infect the summer fish, and these latter the autumn ones, and this goes on year after year.

FIG. 146.—18-lb. Female Salmon, unspawned. November 1900.

The falls of Tummel, Garry, Lochy, Dochart, and Lyon help

the disease greatly, for the fish keep jumping at these falls continually and cut themselves on the rocks, thus rendering them-

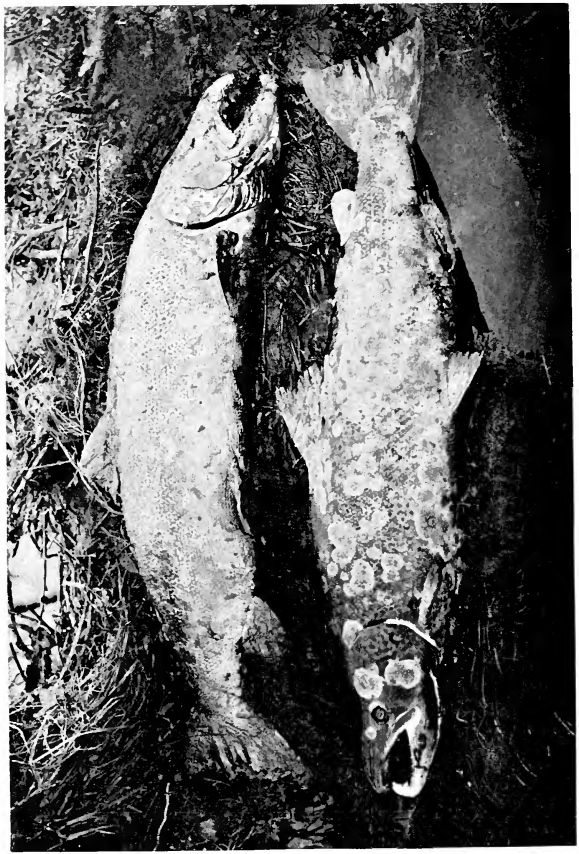


FIG. 147.—Two Male 40-lb. Salmon, unspawned, found together as shown, cast up on the beach. December 1906.

selves more subject to the disease. They cannot proceed farther, and the number of diseased fish soon increases, and each new fish on coming among them becomes affected, so that the pools below the falls soon swarm with them. By April they begin

to die, and continue to drop off until the end of the spawning season, when nearly all die. So infectious is the disease that three years ago on the river Almond about a hundred fish died per day in a distance of less than a mile. Whenever there was a slight flood in the river large numbers of fish without a spot on them ascended, and in the course of a few days nearly all became affected and died (Fig. 146). One or two white spots appear on the head or the dorsal fin. These are at first very small, but in two or three days the disease spreads rapidly. The fish jumps frequently, as if to try to rid itself of it, but soon becomes exhausted and dies. Autumn fish appear better able to withstand the disease than spring fish just from the sea, for a spring fish will often die with only one spot on its head no larger than a shilling, while an autumn fish will live although its body is almost entirely covered. The disease takes the greatest hold when a fish is about to spawn, more especially if the weather be cold, and many hundreds fall victims to its ravages. The accounts

FIG. 148.—16-lb. Female Salmon, partly spawned, almost dead. November 1906.

of the number of dead diseased fish in different rivers that one frequently reads, do not give an adequate idea of the numbers that die, for when a flood comes it sweeps them down in thousands, and they are carried out to sea or left in the estuaries, and perhaps not one in fifty is noticed. All the season through diseased fish drop back daily, many of them reaching the salt water alive. As long as the river continues low many can remain in it, but when a flood comes they are unable to resist the strength of the current. Whenever they lose control of themselves they roll over and very soon die. If the disease died with them it would not be so serious, but weeks after death the disease continues to develop, until every part of the fish is covered to the depth of a quarter of an inch. In Fig. 149 I have scraped away a part to show the thickness of the fungus.

FIG. 149.—Showing fungus developed after the fish was dead for a considerable time. See two parts scraped off.

In order to prove that fungus attacks dead fish, I tied a clean fish without a spot on it to a stake in the river and left it there for a fort-

night. On my going back I found fungus had attacked it in the same manner as on a living fish. When the fish come from the sea they appear to be, judging from outward appearance, entirely free from disease, as no

FIG. 150.—7-lb. Male Grilse, showing fungus partly developed on head. December 1905.

spots can be detected on them. The greatest loss through the disease is to the net fisher, for the fish that die have been of no service whatever. Had they survived they would have become kelts, have gone to the sea, and returned as clean fish double or treble the weight. Not only so,

but all those escaping the nets would have spawned had not the disease attacked them. This of course is the greatest loss of all. The disease

Fig. 151.—20-lb. Female, Showing fungus fully developed on head. December 1904.

also deprives the angler of part of his sport. When the fish becomes affected it is too much concerned with trying to rid itself of the disease

to have time to look at the angler's lures. Besides, it is repeatedly jumping out of the water at various angles, and while under water is almost constantly rubbing itself against the bottom or on rocks or stones, often turning on its back and sides in its endeavour to be rid of the fungus. Loch Tay has fallen off greatly since the disease commenced, and the wonder is that the supply has kept up so well during the last twenty years. Much has been said and written about preventing the disease, but little or nothing has been done towards stamping it out. Of course, although a cure were discovered, the difficulty would be how to apply it.

I am of opinion that if all proprietors on affected rivers were to clear away all obstacles and allow the fish to have a clear run, they would distribute themselves over the whole river course, instead of as at present being huddled together under weirs and falls and in polluted parts of the river. Many of the fish would thus be out of reach of the disease. Every fish that became affected in the higher reaches during spring and summer should be destroyed to prevent the rivers from becoming polluted for the autumn run, which is by far the largest. If the disease continued it would be advisable to erect a barrier across the river and catch every fish that came up in spring and summer, and keep them in ponds and spawn them. Any that showed signs of disease could thus easily be treated. I should also recommend that all dead and dying fish be removed from the river. Until now this has only been done in a half-hearted way. Not only salmon but sea-trout, trout, grayling, and even sparling are subject to the disease. Those who wish to study the salmon disease should read *The Cause of the Salmon Disease*, by J. Hume Patterson, Glasgow. On page 12 he sums up as follows:—"1st, The Fungus *Saprolegnia ferax* is not the cause of the salmon disease. 2nd, The disease is due to the invasion of the tissues of the fish by a special bacillus (*Bacillus salmonis pestis*). 3rd, The bacillus gains access through abrasion or ulceration of the skin, and the disease is apparently not contracted when the skin of the fish is in a healthy state. 4th, *Bacillus salmonis pestis* can be transmitted from dead

diseased fish to other dead fish in the same water; and 5th, from dead fish to living."

I do not agree with Dr. Patterson, however, in regard to No. 3 above. As I have already mentioned, I made a special study of the fish which came up the river Almond from the Tay. Sometimes about a hundred came up in one day and could get no farther. In two days about half of these fish became diseased, and in other two days the remainder became affected. None seemed to escape and almost all died. Surely all could not have had abrasion or ulceration of the skin, as they had no rocks to pass or weirs to surmount, and were only one mile from tidal water.

I have always wondered how a salmon was able to take care of itself in the sea, for we see them brought ashore without a scratch or a scale ruffled. I believe that every salmon on entering a river is subject to disease. Fish, if not badly affected while spawning, often revive in the kelt stage, go to the sea, and return again. About April many of the kelts heal up quickly. It is not so, however, with the clean fish; they continue falling down the river, and are daily caught in the nets. I have been told that since the storage of water was commenced in the Helmsdale the disease has disappeared. Before the water was stored I have counted dead fish by the score in it.

Dr. Patterson says *Bacillus salmonis pestis* grows well in the sea water, whereas *Saprolegnia* does not grow. Therefore a diseased salmon entering the sea and returning to the river apparently free from fungus cannot be said to be free from the disease. Many people believe that a diseased salmon on entering salt water is cured of the disease; if this were the case there would be some chance of its dying out, but there is not the least doubt that Dr. Patterson is right, for if it were not so the disease might appear in one river and not in another. I am strongly of opinion that the disease came from the Eden at Carlisle, where it first made its appearance; that from there it was carried to the East Coast by gulls, found its way to the Tweed, and from thence to all the rivers north of the Tweed as far as to the Thurso on the North Coast.

SEA-TROUT

(Salmo trutta)

THE sea-trout is one of the best sporting fish we have in Great Britain, and is, besides, of greater value than any others to those who are fortunate enough to possess waters that contain them. They are netted in great numbers in our rivers and in the sea, and when we consider the vast quantities that are sent not only to our own markets, but also to those on the Continent, the revenue derived from them must be very great.

I consider the sea-trout distinct from the salmon and grilse. Any one who has the opportunity of observing them proceed up a river can prove this by the way in which they run. No matter what its size may be, the sea-trout always runs in a zig-zag fashion—first to the one side and then to the other. The salmon, on the other hand, runs in a straight direction. Another way of knowing the sea-trout is by counting the number of scales. There are fourteen from the adipose or dead fin to the lateral line. The salmon, on the other hand, as may be seen from the illustration, has ten (Fig. 153). By counting the scales, then, is a simple way of distinguishing between them, and is so sure a guide that no mistake need be made. From the photographs of sea-trout, both large and small, which are given it will be seen that they vary a great deal.

Having made a careful study of this subject for thirty years, and having collected all the information I could bearing upon it, I have come to the conclusion that the sea-trout is the same fish as that which is called white trout, bull-trout, gray trout, peel, sewin, brith-dail, salmon-trout, and many other names. In the grilse stage it is known

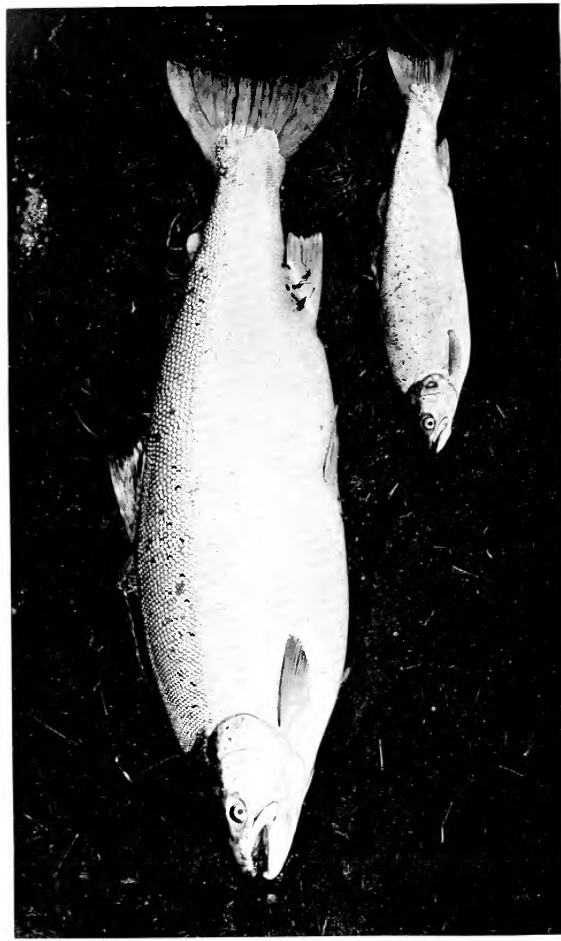


FIG. 152.—19½ lb. Sea-trout. Largest ever caught in the Tay. June 1908.

as herling, whitling, Finnock, Lammasmen, etc.; while in the smolt stage it is called yellow-fin, orange-fin, black-fin, and silver-white. In fact, almost every district has a different name for each of the three stages. While much confusion is thus caused, it would be a

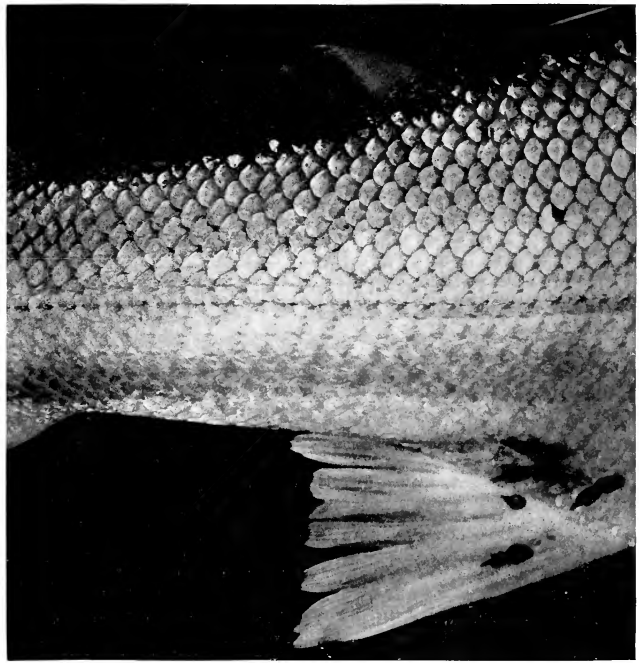


FIG. 153.—Salmon, showing number of scales from adipose fin to lateral line to be ten.

very simple matter to call them sea-trout, in the grilse stage whitling, and in the smolt stage yellow-fin (Fig. 155).

The history of the sea-trout differs widely from that of the salmon; but I shall explain this later. It is often difficult to tell a parr of the yellow-fin before its fin becomes yellow, although those who have experience in dealing with them have no trouble whatever in dis-

tinguishing them at a glance. In marking the salmon smolts we are not aware of having made a single mistake in this connection, although there were plenty of yellow-fins also in the net, and no wired sea-trout have been caught. Although yellow-fin is the name applied to the smolt stage of the sea-trout, it must not be understood all have yellow fins,

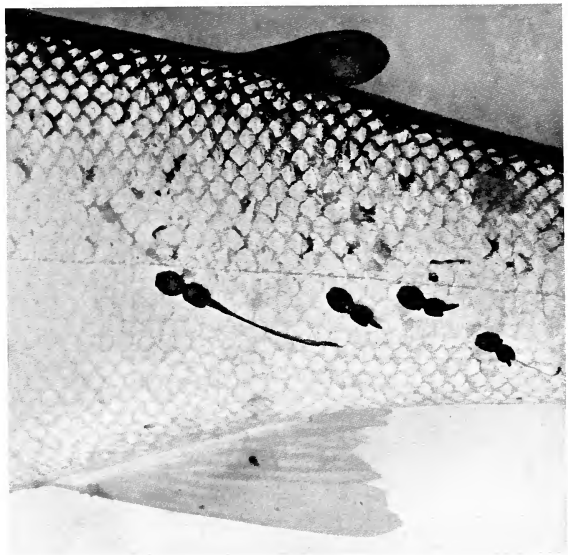


FIG. 154.—Sea-trout, showing scales from the adipose fin to the lateral line. The four specks are sea-lice.

for many have their fins of quite as dark a colour as those of a salmon smolt (Fig. 156). As a rule, the yellow-fins are larger than the salmon smolts, and this may be accounted for by the fact that the former are from a month to six weeks older, and therefore have an earlier start than the salmon smolts.

I am of opinion that the yellow-fins do not go far out to sea before returning as whitling (Fig. 157) about the end of June. During the whole season we catch them, in the estuary, in all stages

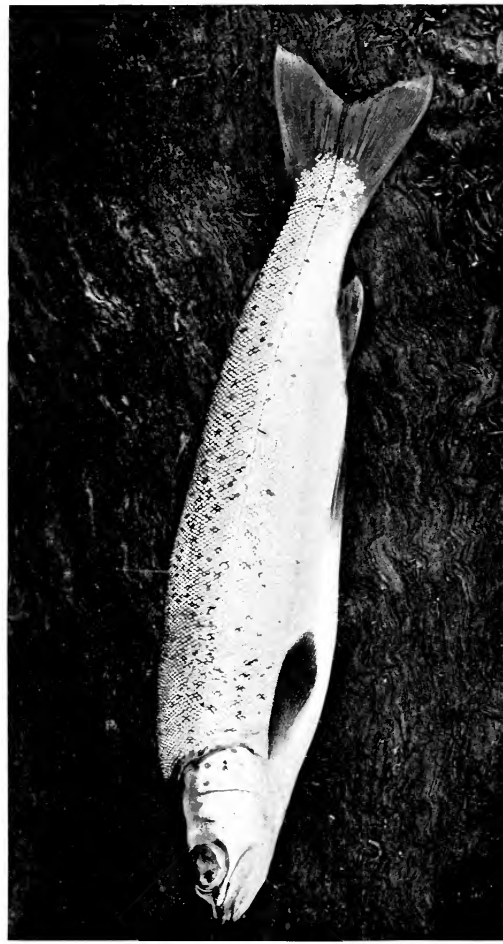


FIG. 155.—Life-size Yellow-fin Smolt of the Sea-trout. 1st May 1905.

up to half a pound. A study of the scales goes to prove that after going down and returning as whitling they have only been from three

FIG. 156.—Life-size Yellow-fin Smolts of Sea-trout, going to sea. River Tay. 1st May 1905.

to four months away. If yellow-fins are prevented from reaching the sea by being confined in a loch, they will become sea-trout and weigh about 16 oz. by the end of the year, and appear quite as bright as those

just returned from the sea. The one from which the illustration (Fig. 158) was taken was a perfect specimen when I caught it. The yellow-fins, then, which return about the end of June, have only been three months in the sea. At first they are very small, weighing only about a quarter of a pound, but they continue to increase in size up to the end of November, when the largest weigh about 1 lb. While they remain in fresh water they feed on larvæ, flies, worms, etc., the greater number of them, however, prefer the tidal water, and in the Tay very few are caught more than ten miles above this. They remain in the river until the end of December, when they begin to go down in consider-

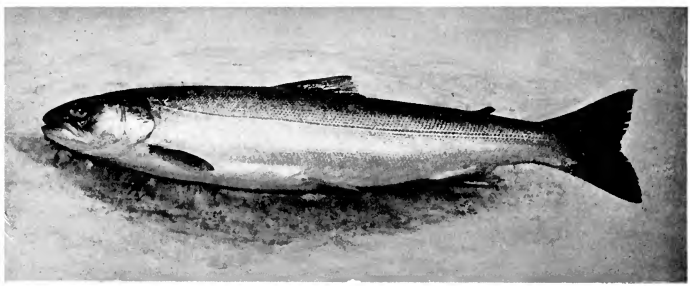


FIG. 157.—½-lb. Whitling. First return from the sea. July 1900.

able numbers. Of course, some may go down somewhat earlier, but from December until the beginning of May they are constantly going down, and, if the weather is warm, practically all will have disappeared from the river by the 1st of May. Their condition greatly depends on whether the winter has been cold or warm, and, of course, the warmer the weather the better will be their condition, as they have more to feed on and are more inclined to feed then. During some seasons they are so thin that they have the appearance of kelts; but by October and November, if the weather is warm, they are in good condition again, and the same applies to the months of March and April. When the March browns and blue duns appear on the river, the whitling feed ravenously and seldom allow a fly to pass.

I now come to a point on which there is great difference of opinion, namely, whether, while in this stage, they spawn and become

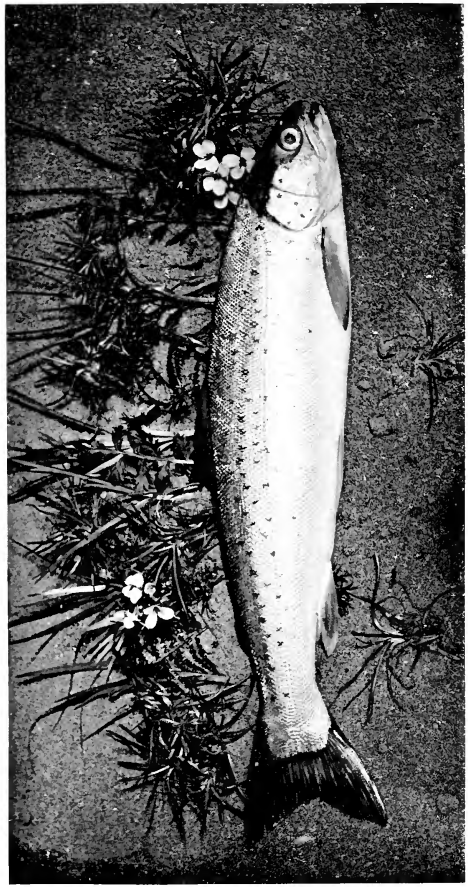


Fig. 158.—12-oz. Sea-trout, confined in Bertha Loch one year after becoming a smolt. June 1906.

kelts. My opinion is they do not spawn. I have seen them at all times and have looked for one with ova, but never found one. Poachers catch them all through the winter and always find a ready

sale for them. They are sold in the open market, too, all through the spring, and anglers are allowed to catch them. In some rivers the autumn months are the best for catching them, while in others they take more freely in the spring. In the Tay and the Earn spring is the best time. On one occasion, on the 10th March, I caught with fly eighty of them, averaging three-quarters of a pound in weight. The largest, which scaled one and a quarter pounds, is the largest I have ever caught. In July, August, and September thousands of small whitling are caught and called sea-trout. These would be better left in the river, as they are little better than smolts. If this were done the number of sea-trout would soon greatly increase.

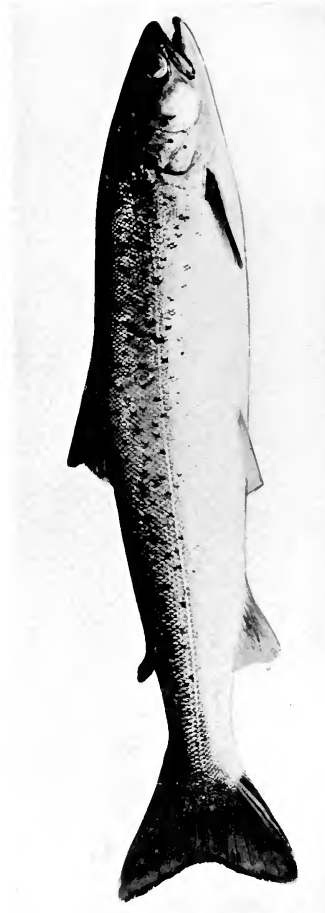


Fig. 159.—1-lb. Whitling. April 1904.

From what has been said it will be seen that the habits of the sea-trout differ widely from those of the salmon, and these differences may be summed up as follows: — (1) The sea-trout comes into fresh water nearly a year before the grilse of the salmon. (2) It feeds in fresh water, which the salmon does not. (3) It does not spawn on its first return to fresh water. After the whitling goes to sea it remains there for three or four months, and comes up as a sea-trout from 1 to $2\frac{1}{2}$ lbs., according to the length of

time it remains in the sea (Fig. 161). In the earliest rivers they begin to run in January, although only in small numbers, and continue

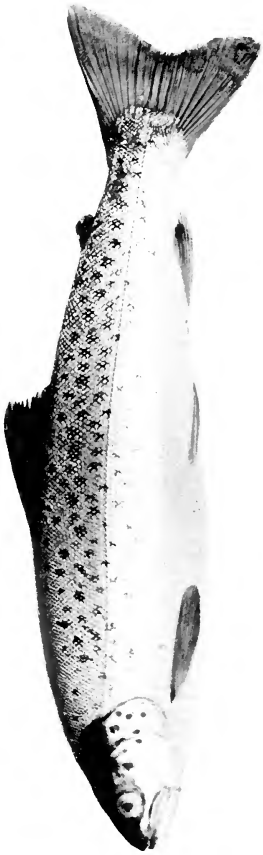


Fig. 160.—1½-lb. Sea-trout. 15th May 1904. Second return from the sea.

Fig. 161.—2½-lb. Sea-trout. 1st July 1904.

till October, but of course the seasons have a great deal to do with their running early or late.

The Tay, I dare say, is the earliest river in Great Britain, and one would expect them in it as early as in any river. Every spring

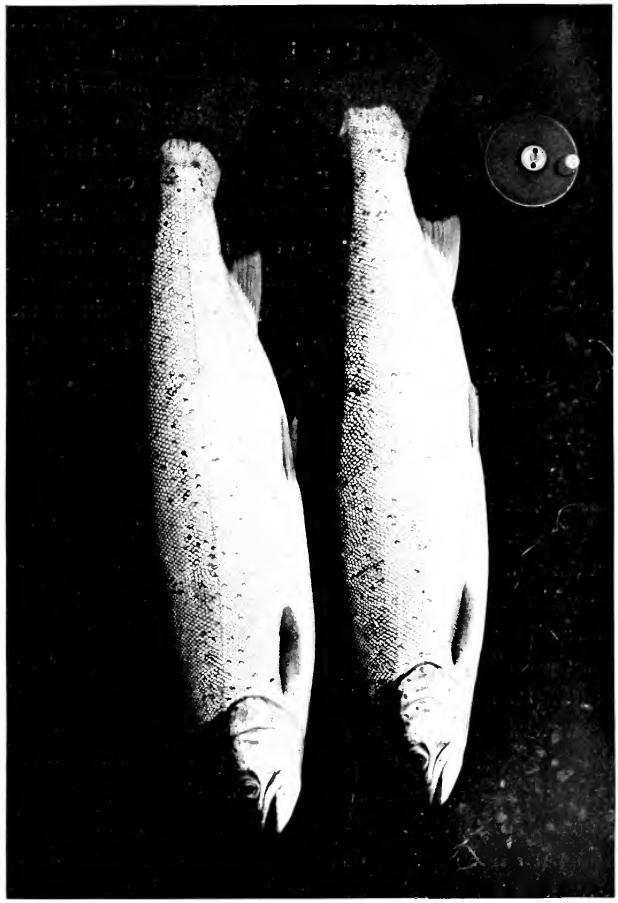


Fig. 162.—2-lb. Sea-trout, caught in the Tay 5th February 1907.

paragraphs appear in the public press stating that most of the sea-trout caught in early spring are kelts (Fig. 162). I have the numbers

caught in our nets on the Tay for the last eight years. The average number in February is 20; in March, 300; in April, 400; in May they quickly increase in numbers, and continue to do so till the middle of July, when few come up. They are then caught mostly in the lower reaches of the tidal part of the river. Most of these are large and much inferior in quality to the earlier ones.

FIG. 163.—1½ oz. 27th April 1907.

Strange to say, on the 5th February of this year (1908) we caught more sea-trout at one station—Almond Mouth—in one day than we had caught in a month in some other seasons. Since then they have greatly increased, and we are now (24th April 1908) getting from 100 to 120 daily, all in perfect condition, averaging about 1½ lbs. in weight. None of these have spawned, although all will spawn this season. These sea-trout are now a little over three years of age, and are on their second return from the sea. Now the grilse of the salmon have not yet returned once to the fresh water, nor will they do so until the middle of May or the beginning of June. No doubt the mild autumn and spring had something to do with the running of these sea-trout so early, and with their being in such fine condition.

FIG. 164.—1 lb. Caught at sea, 31st July 1907.

All these sea-trout will hasten on to the higher reaches and will go as far as the water will allow them. The age of these sea-trout can be ascer-

tained from their scales as in a grilse, with this difference, that in the whitling stage new rings are added during their stay in both salt and fresh water. The number of rings will be found to be forty-nine, making them the same age as the grilse, which have not yet returned from the sea.

I give also a few illustrations of the scales of sea-trout of different sizes (Figs. 163, 164, 165). The sea-trout weighing about $1\frac{1}{2}$ lbs.,

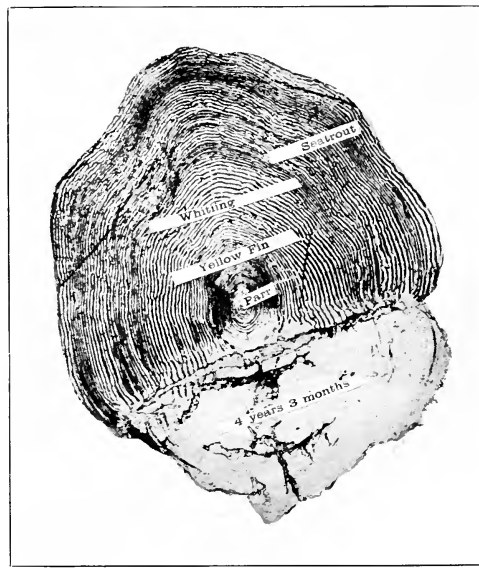


FIG. 165.—9 lbs. Coquet, 25th July 1907.

as I have already said, run up as far as the water will take them and spawn about the beginning of October. They select gravel of a non-shifting nature and very much finer than that which the salmon selects. Their movement in spawning is very much quicker than that of a salmon, and they take much less time to deposit their spawn, this only occupying them from two to four days. After spawning they become kelts, fall back into the pools, become very lean, and remain in the pools for some time, until they recover from its effects. They

then roam about and feed freely, and come into so good condition by April that one has some difficulty in recognising them as kelts. By

FIG. 166.—18½-lb. Sea-trout, caught in the Tay June 1900.

studying the scales, however, one can easily make sure of his ground, as scales taken from a kelt are always broken at the edges. These kelts

go down from January to May, and some of them return again in July, double what they weighed on going down. Others remain longer in the

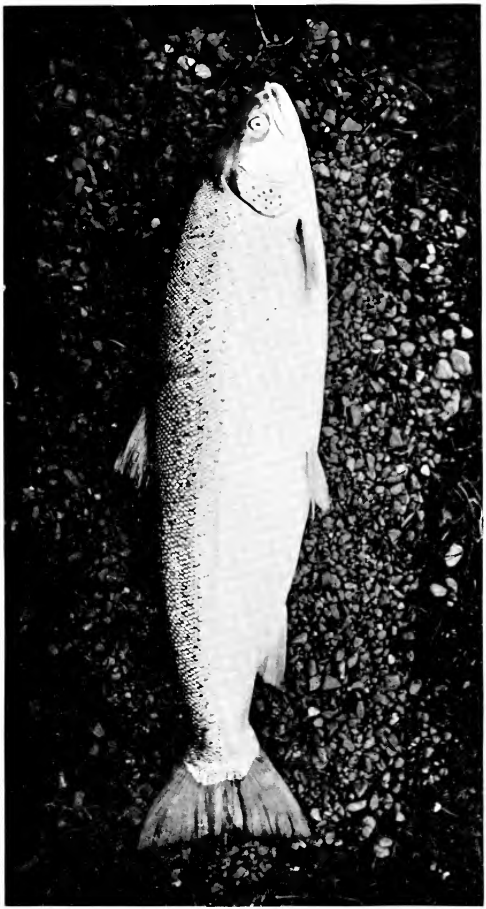


FIG. 167. – 14-lb. Tay Sea-trout. 14th August 1906.

sea, and come up in February, weighing from 3 to 5 lbs., while others remain till July and are from 5 to 8 lbs. Those that are on their second

return from the sea and have not spawned are in the best of condition, and are so pink-fleshed and so well flavoured that I think no fish are

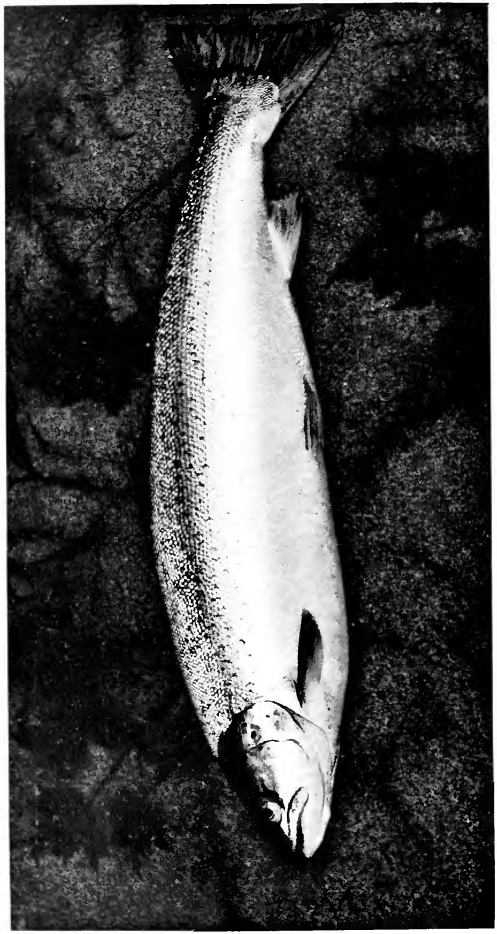


FIG. 168.—7-lb. Sea-trout, from the Coquet, Northumberland. 25th July 1907.

better than they are from April to the middle of July. After spawning they resemble the salmon, become white in the flesh, and much coarser.

Sea-trout occasionally grow to a very large size. One was got in the nets at Ballathie weighing 18½ lbs. (Fig. 166), and we caught

Fig. 169.—Sea-trout from the Coquet, average 7 lbs. 25th July 1907.

one on 28th June 1907 weighing 19½ lbs. This was the finest specimen I have ever seen (Fig. 152). We often capture sea-trout from 6 to 12 lbs., but very seldom do we get monsters like this.

All round our coasts the sea swarms with sea-trout, they are

found in Orkney, Shetland, and the Outer Hebrides. In the river Grimersta they are also plentiful. On one occasion I visited the

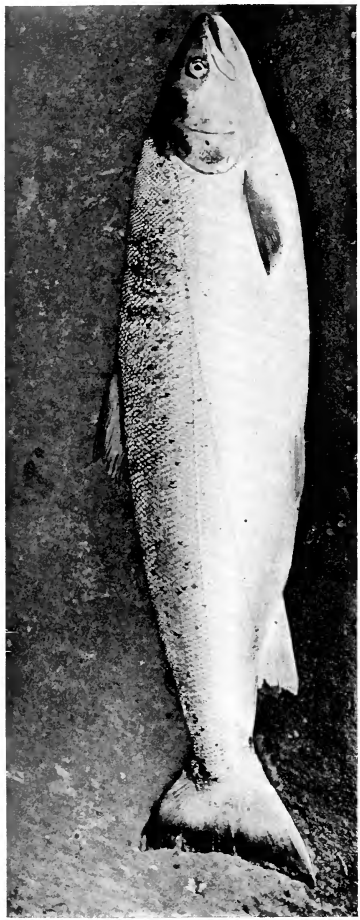
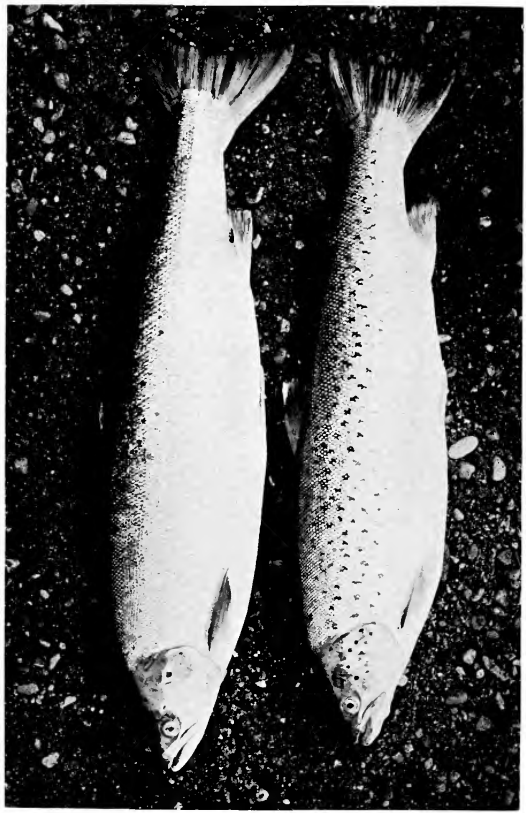


FIG. 170.—9 lbs. Supposed by fishermen on the Coquet to be a cross between Salmon and Sea-trout. 9th July 1907.

latter to study the kelt sea-trout, and in April I caught many in good condition, dissected them, and found they had been feeding on

the larvæ of Ephemeræ and caddis flies. Most of the clean ones were newly from the sea and weighed about 1 lb., but no large run



(1) (2)

FIG. 171.—(1) 7-lb. Grilse. (2) 7-lb. Sea-trout. 7th July 1906. The Tay.

of sea-trout takes place in the Lewis until later in the season. In the Kyles of Durness and Tongue large numbers are taken with sand eel and minnows. The river Laxford and Loch Stack swarm with sea-trout, where there are no nets to reduce their number.

In a dry season sea-trout collect in great numbers at the mouths of small streams, and seem desperately eager to obtain a little fresh water. When in this excited state I have tried to catch them in the sea,

Fig. 172.—8-lb. Sea-trout. The Tay. 19th August 1907.

but could not persuade them to look at a fly. It is quite different, however, in Shetland, where sea-trout often take a fly quite freely in the sea. Sea-trout run much faster than salmon, and being smaller they can

(1) (2)

FIG. 173.—(1) 8-lb. Sea-trout. (2) 5-lb. Grilse. Tay. 15th July 1907.

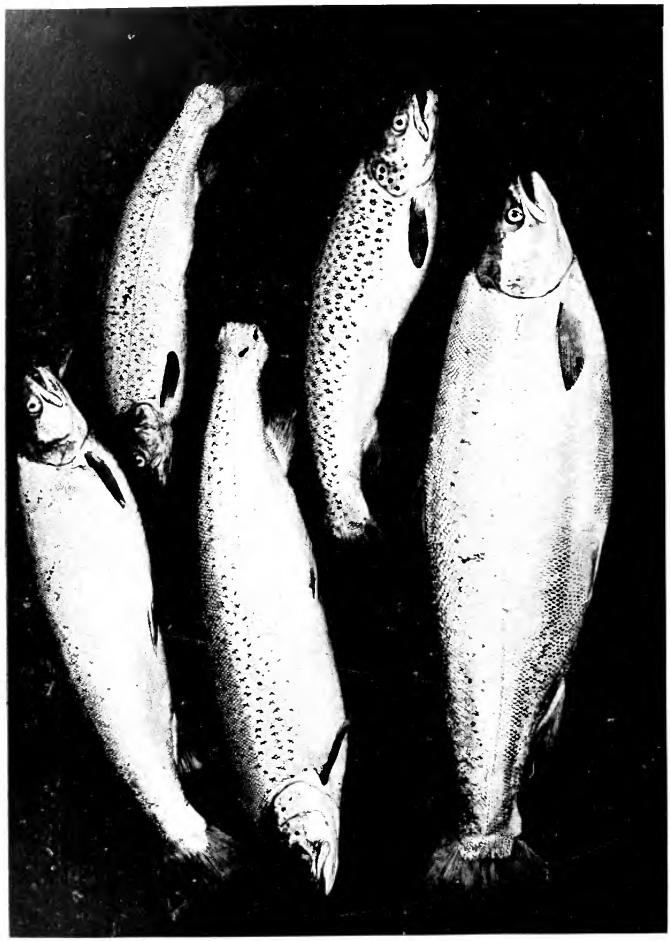


FIG. 174.—Different types of Sea-trout, 2 lbs. to 8 lbs. The Tay. August 1905.

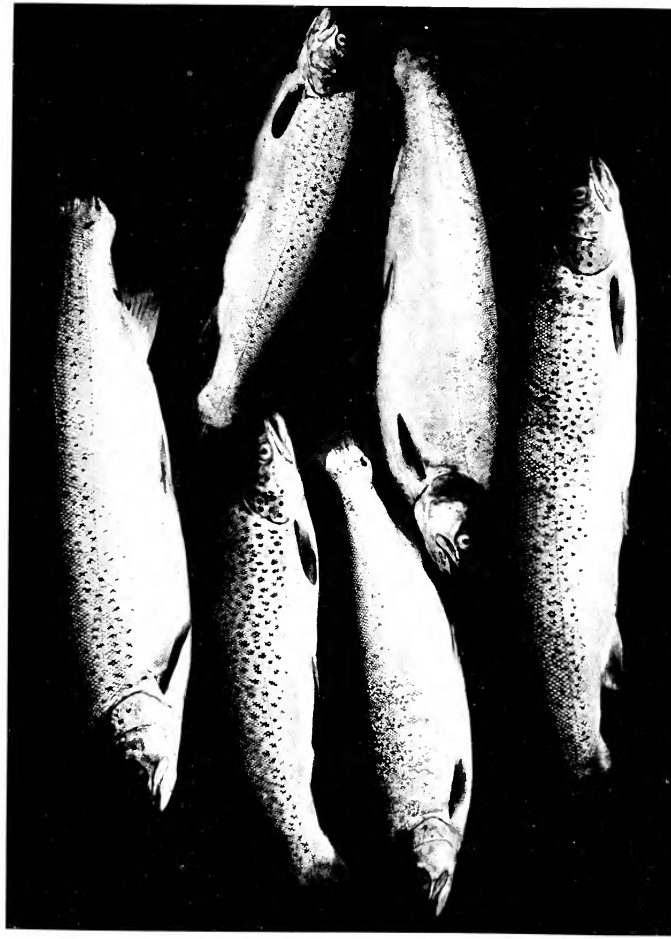


FIG. 175.—Different types of Sea-trout. The Tay. August 1905.

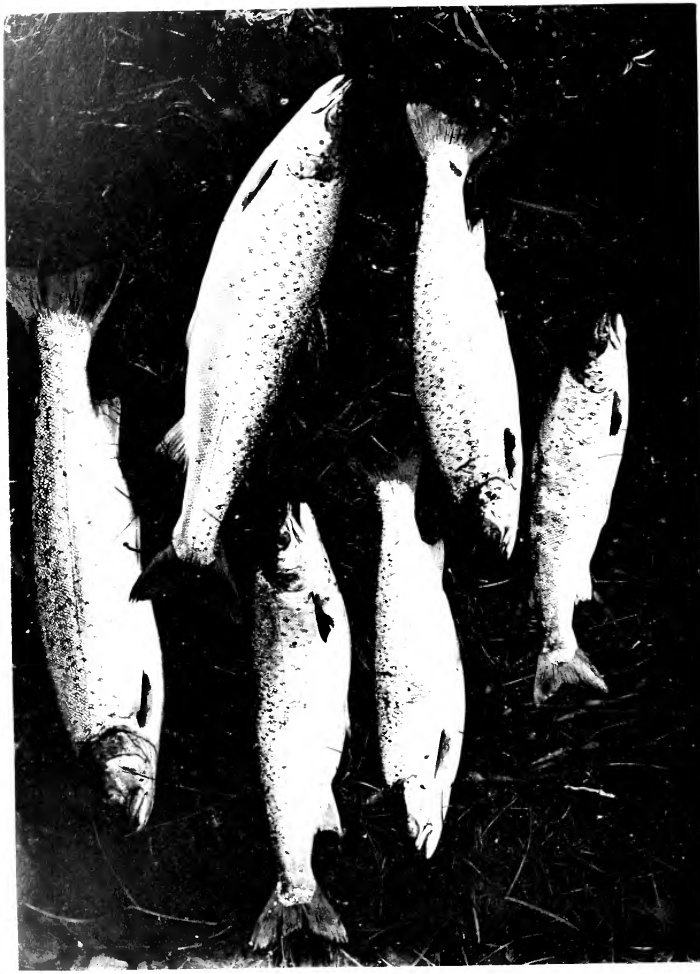


Fig. 176.—Sea-trout, caught with fly in the sea. Scourie, Sutherland. July 1904.

run with much less water. During summer they may be seen running over weirs and up shallows with their backs above water. In

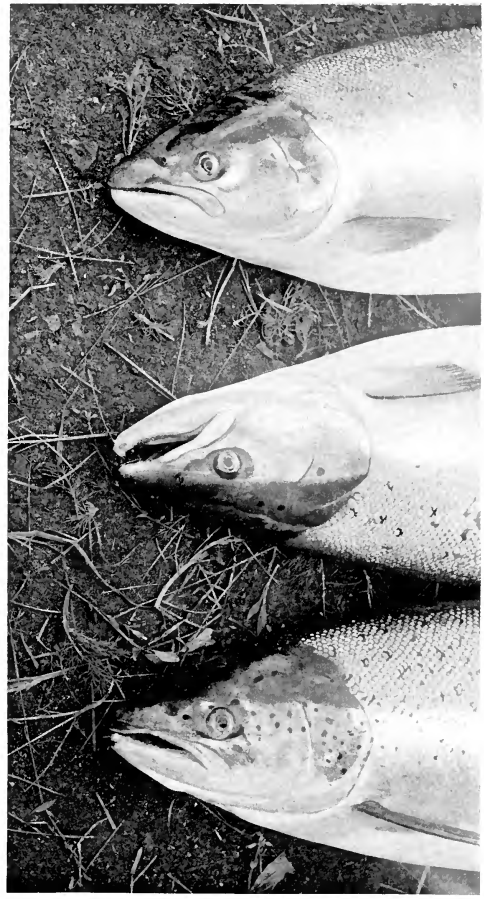


FIG. 177.—Heads of Sea-trout. July 1907.

summer, a mild night when there is a little fresh water in the river is their favourite time for running, but slight frost soon stops them.

In high water the sea-trout appear to evade the lower nets, as most of those caught are got in the higher ones.

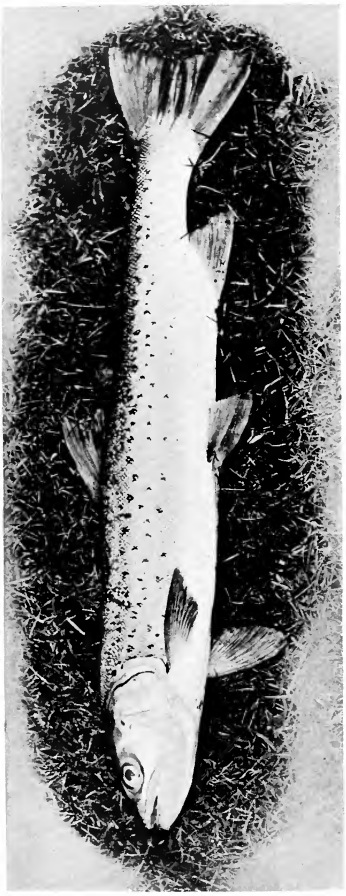


Fig. 178.—5 lb. Kelt Sea-trout, from the River Earn. March 1901.

Bull-Trout

I am inclined to think bull-trout are neither more nor less than sea-trout, and why they are called bull-trout I cannot tell, for I have examined many and can find no difference between them and sea-trout. The river Coquet in Northumberland is famous for its bull-trout, which come up in large numbers in June, and continue to increase in number until the spawning season. Those running in the earlier part of the season are in so fine condition that it is difficult to tell them from salmon. Many of them are from 5 to 10 lbs. in weight, and when in good condition they are really very handsome fish; but for the table they are inferior to salmon, their flesh being white as a rule. I think, then, that instead of being called bull-trout they ought to be called sea-trout. The younger ones, weighing from 1 to 3 lbs., are excellent for the table, but as they grow older they become coarser and whiter in the flesh. The feeding may have something to do with this.

At one time the Coquet was a splendid salmon and grilse river, but now holds very few. This is not to be wondered at, as the passage over so many high weirs prevents salmon reaching the higher parts of the river to spawn. A sea-trout will surmount weirs and go through difficult fish-passes where a salmon would fail. I am at present designing fish-passes for these weirs to allow salmon to pass up, and I hope to see the time when salmon will again be plentiful in this river.

I have compared these so-called bull-trout with the sea-trout of the Tay, which are never called bull-trout, and I can find no difference except that the large ones in the Tay are better fed. They have all the same number of scales—fourteen from the adipose fin to the lateral line. Many of them are supposed to be crosses between a salmon and a sea-trout, which no doubt some of them are. I give the photograph of one which the fishermen of the Coquet thought to be a cross (Fig. 170). What the result of the after-cross would be I leave others to judge. These sea-trout are distributed over the whole of Great Britain, but are more plentiful in the Coquet and in the Tweed than in any other river I know of. As anglers are the people who are chiefly concerned with the life-history of the Salmonidæ, there ought to be some simple way for their determining what salmon, sea-trout, and trout are, without having to wade through books and become more confused than ever. *Salmo salar* should be called fry, parr, smolt, salmon; foul salmon in the spawning season, and kelt salmon after spawning. *Salmo trutta* should be called fry, parr, yellow-fin, sea-trout; and if a further distinction is wished, grilse could be called young salmon, and whitling young sea-trout.

In small rivers, such as the Dovey in North Wales, where salmon have been over-netted and poached, they have decreased while the sea-trout have increased, showing that sea-trout are more difficult to exterminate than salmon. When on this river not long ago I found that the belief amongst fishermen there is, that the sea-trout—*Salmo trutta*—is different from the bull-trout; but besides sea-trout and bull-trout they have another which they call brith dail, because it is

different in colour, having red spots, and being much redder all over. Judging from the specimens of these sea-trout which I saw, I have no hesitation in stating that they are exactly the same as we have on the Tay. It is thus most confusing that in almost every locality the same fish should be called by different names, at different periods, simply because they change their colour with the seasons. I wonder what an

FIG. 179.—Gill of a 20-lb. Salmon which has spawned and returned as a clean fish, showing maggots on gill, which is partly eaten away.

ornithologist would say if we called the ptarmigan white grouse in the winter, yellow grouse in the breeding season, and grey grouse in the autumn, simply from its colour!

The sea-trout in summer is silvery, in autumn grey with more spots showing, and in the spawning season red. I do not think it advisable to encourage large sea-trout in the clean state for sporting purposes, for when they grow large they seldom take fly, and in the kelt state rise freely and will take almost any bait. I attribute the

inferior quality of the large sea-trout to its having spawned, and the oftener it spawns the coarser it becomes.

There is yet another fish—the so-called salmon bull-trout. These are found in all our rivers in which salmon are found. In my first edition of this work I said these fish grow to as large a size as the largest salmon. Since then I have had reason to alter my views as I find this is not the case. Of those which have come under my notice the heaviest scaled 42 lbs. and I find very few to attain the weight of 40 lbs. It is only reasonable to expect that this should happen as the time occupied in spawning takes the fish away from the sea where the increase in weight takes place. They are readily distinguished from the salmon by the number of spots appearing along their sides, and as a

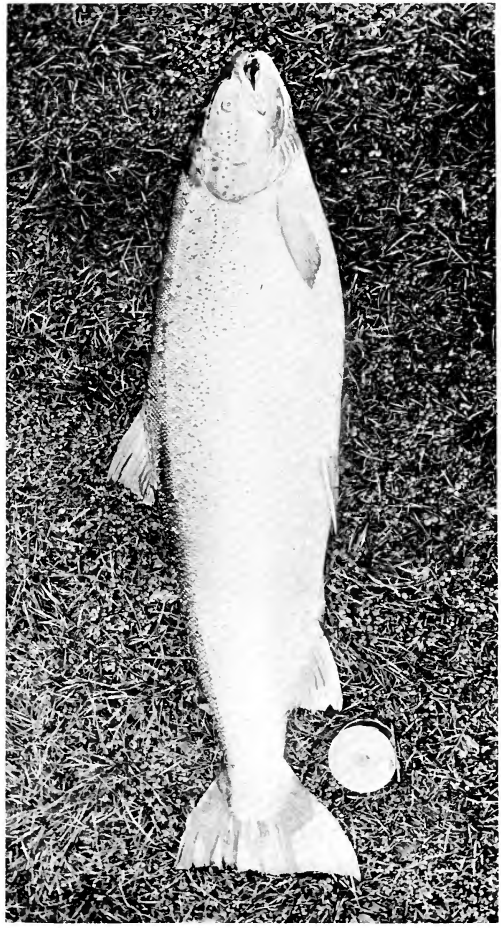


FIG. 180.—39-lb. Female Salmon Bull-trout. Second return from the sea, showing spots. Caught with fly by Archibald Coats, Esq., 3rd September 1907.

rule the head is shorter and parasites are always present in their gills.

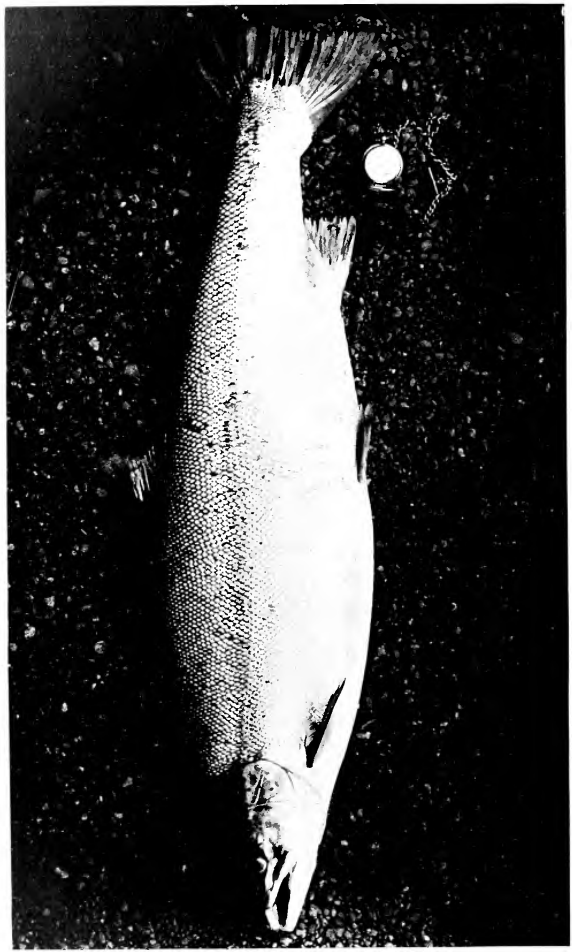


Fig. 181.—40-lb. Tay Salmon. First return from the sea, not having spawned. June 1904.

In fact, the more spots there are on their sides the more parasites are there in their gills, and sometimes the gills are nearly eaten away. See

illustration of a gill (Fig. 179), and also illustration of the difference between a salmon (Fig. 181) and a salmon bull-trout (Fig. 180). Occasionally one does come across a fish having spawned and returned as a clean fish with no spots on its sides but, if the gills be inspected parasites are always present. These fish are inferior to the salmon, and usually bring twopence to threepence per pound less in the market. Their flesh is often whiter and not so well flavoured. Having had several bull-trout from the Tweed, I could discern a great difference between them and the bull-trout of the Tay. Several years ago I drew the attention of Sir Herbert Maxwell to them, and he was astonished to hear that we had bull-trout up to 40 lbs. and over. Having captured one 42 lbs. shortly afterwards, I sent him a photograph of it, and he declared it to be a bull-trout. I also brought them under the notice of Dr. Kingston Barton for examination, and he found them to be seventeen per cent richer in fat than other salmon.

When he called one day at our fish-house, I drew his attention to the spots on the fish, and he thought the richness of the feeding might cause these as well as the parasites in the gills. Since then our marking of fish on the Tay has clearly proved that the so-called bull-trout of the Tay and many other rivers are true salmon. These bull-trout should not, of course, be confused with the bull-trout of the sea-trout. The former have the same number of scales from the dead fin to the lateral line as the salmon. All the grilse kelts, small spring fish kelts, and in fact all the kelts which we marked, were so-called bull-trout when they returned again. I have watched them carefully in our fish-house, and in July 1907 there were nineteen per cent of them. (For further information see page 64.)

It is remarkable that almost all the bull-trout are females, and this is, no doubt, accounted for by the fact that there is greater mortality among the males during the spawning season, thus leaving few but females to mark. From the study of these I am now convinced that all fish—salmon, grilse and sea-trout—that have spawned are inferior to fish that have not spawned. It was indeed an "eye-opener" to me to find one of our wired smolts of 1905 return on 9th

August 1907 for the first time weighing 27 lbs., for hitherto we thought fish of this size caught in the autumn had been in the river before and had spawned. Still more convincing is the fact that we have never captured a Tay bull-trout that has not spawned, clearly proving what I have already said. A reference to the illustrations of the scales will explain this more clearly. The illustrations of these salmon should also be examined and the spots noted (Fig. 182). These may be from the grilse that have spawned, from the small spring fish, or from the larger fish.

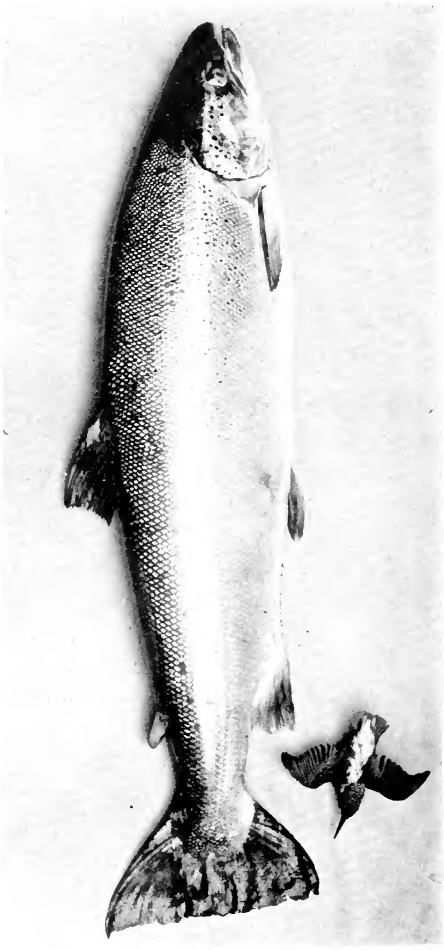


Fig. 182.—42-lb. Tay Salmon. Second return from the sea, having spawned once. See spots on head and shoulder.

The largest female I have noticed, that had spawned, was caught by Mr. Archibald Coats, and weighed 39 lbs. (see illustration, Fig. 180; also one of 42 lbs., Fig. 182). Illustrations are also given of the scales of bull-trout from the grilse, from the small spring fish, and from the larger fish (Fig. 81).

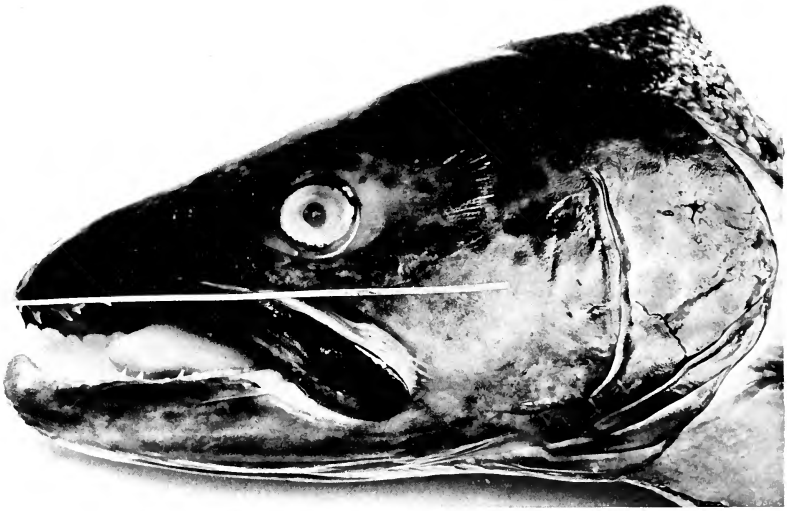


Fig. 183.—8-lb. Male Sea-Trout or Bull-Trout. The Till. 1st August 1911.
Showing the eye above the level of the mouth. The same can be seen in the smolt stage.

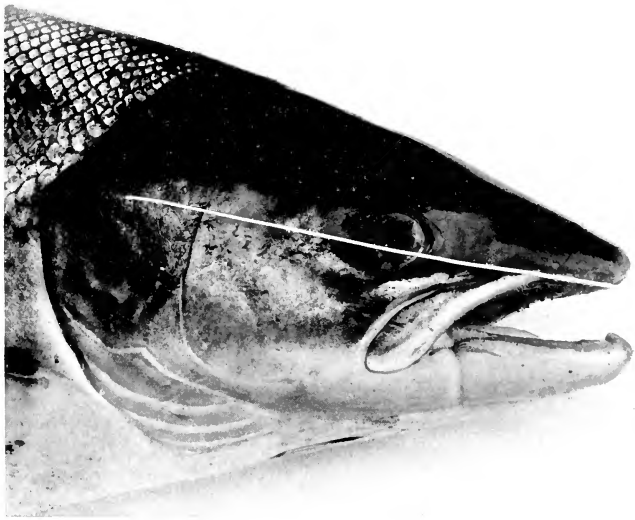


Fig. 184.—16-lb. Female Salmon. The Tay. August 1911.
Showing the eye below the level of the mouth. The same can be seen in the smolt stage.

FIG. 185.—5-lb. Female Sea-Trout. The Tay. August 1911.
Showing the eye above the level of the mouth.

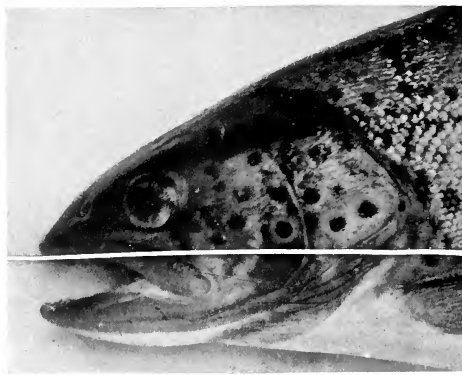


FIG. 186.—2-lb. Brown Trout. August 1911.
Showing the eye above the level of the mouth.

HABITS AND HISTORY OF THE BROWN TROUT

(*Salmo fario*)

To the angler the common yellow trout is by far the most important fish that swims, for more people capture it than any other living thing. The pleasure derived from its capture, too, surpasses that of any other sport, while interest in the study of the trout seems to be inexhaustible. Its shape and colour are so beautiful that no artist can reproduce them. Many naturalists maintain that there are different species of trout in the British Islands—Loch Leven trout, Gillaroo trout, tidal trout, and many others; but from a close study of all these trout for the last forty years, I have come to the conclusion that there is only one species of trout in Great Britain, and that in the different varieties the differences are caused by the nature of the water in which they are found and by the food they eat. I therefore hope that what I have to say will help to solve some of the mysteries connected with this wonderful trout.

The spawning time of trout depends on the locality, and begins about the 15th of October and continues till March. The spawn is generally deposited in places where the gravel is fairly fine, and remains there for a period according to the temperature of the water. If the temperature averages 54° it remains thirty-two days; if 50°, forty-seven days; if 43°, eighty-nine days. The fry when hatched come up through the gravel, and like the salmon fry have a sack attached to their bodies. This sack contains enough nourishment to sustain them for several weeks before they are able to feed. On their beginning to do so they grow so rapidly that if hatched on the 1st of March and food is

plentiful, they may attain a length of 6 inches by October. As

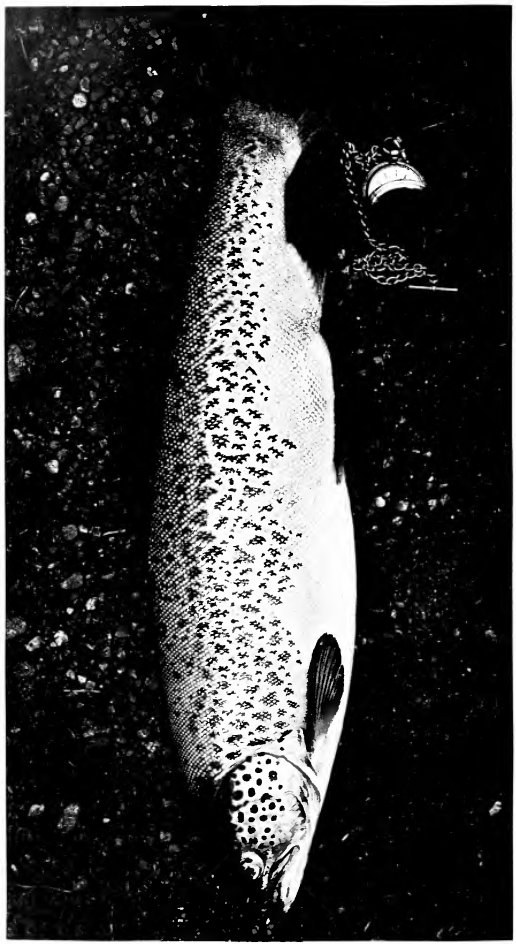


FIG. 187.—9-lb. Durness Trout, Sutherland. June 1908.

a rule, however, they are smaller, and by the following March do not exceed this length. During the winter months they

FIG. 188.—1 oz. Loch Leven.
1st February 1906.

FIG. 189.—½ lb. Loch Leven. 22nd August 1906.

FIG. 190.—¾ lb. Loch Leven. August 1906.

FIG. 191.—1½ lbs. Loch Leven.
25th July 1906.

feed very little, owing to the scarcity of food at this season. They then hide under stones and banks, and in deep holes out of the reach of their enemies.

When the weather becomes warm, about the beginning of April, they leave their winter quarters and roam about in search of food. Towards the end of April a great change comes over them—a change almost as great as that from a parr to a smolt. They now assume a silvery coat, and it is difficult to tell them from the smolt of the sea-trout. During the summer they feed on worms, flies, larvæ, beetles, shell-fish, and many different kinds of flies that are blown on to the loch or stream from the land. By March of the following year, if the feeding has been fairly good, they will be from 8 to 9 inches long, and will weigh about 4 oz. I have seen some, which were kept in confinement and regularly fed, weigh 2 lbs. in two years. The milder the climate the more food there is and the trout have a longer season to feed in, consequently they become larger in a shorter period. In a loch a three-years-old trout is usually about three-quarters of a pound, while in streams they are usually much smaller.

FIG. 192.—2¾ lbs. Loch Leven. 25th July 1906.

In quick-running streams containing little food, many, when three years old, will not weigh more than 3 oz., showing clearly that their size at a certain age depends chiefly on the feeding. At four years of age they should weigh 1 to 1½ lbs.; at five years, from 1½ to 2½ lbs.; at six years, from 2½ to 3½ lbs.; at seven years, from 3½ to 5 lbs. Only a few of them reach this size, and they soon die off. It is only when the feeding is good that a weight of from 3 to 5 lbs. is attained. Trout leave the larger rivers and run up the small ones usually about the 1st of October, and spawn, as I have said, about the 15th of October. A little

frost makes them run quickly to their spawning-beds. They select a place where the gravel is fairly fine and is not likely to shift. Here

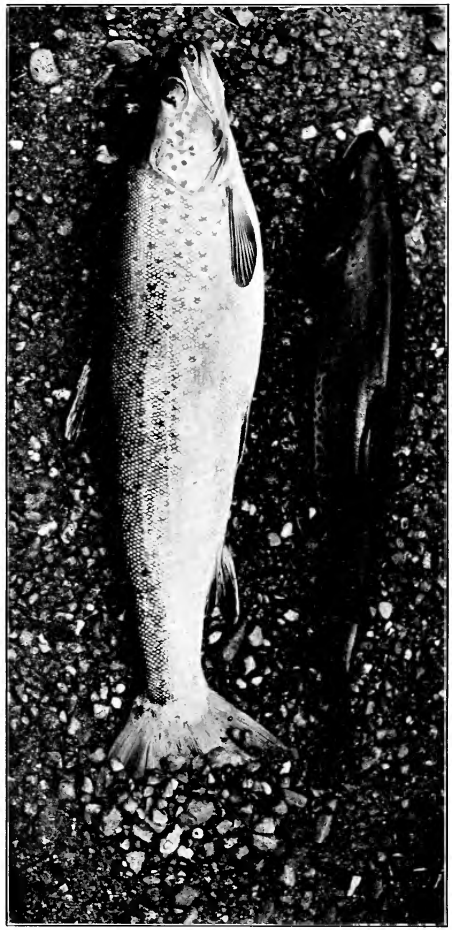


Fig. 193.—Male and Female Trout spawning. Female turned on her side, digging up the gravel.

the female digs a hole in the gravel with her tail, striking four or five times, and making the water dirty. Every three or four

minutes she turns on her side with a flopping motion (Fig. 193), and during this time deposits the spawn. The male is generally

Fig. 194.—Trout spawning-bed, showing the gravel heaped up.

beside her throughout the process of spawning, which usually occupies from two to four days, according to the nature of the water and the

weather. Too little water sends her off, whilst severe frost does the same for a time.

Fig. 195.—2 lb. Brown Trout Kelt. Loch Dupplin. March 1906.

The spawning-bed made is about 18 inches long, 12 inches wide, and from 4 to 8 inches deep, and the gravel is heaped up in the shape

of a mole's hillock (Fig. 194). While the female is spawning the male keeps guard, and if any intruders come up from behind, as they usually

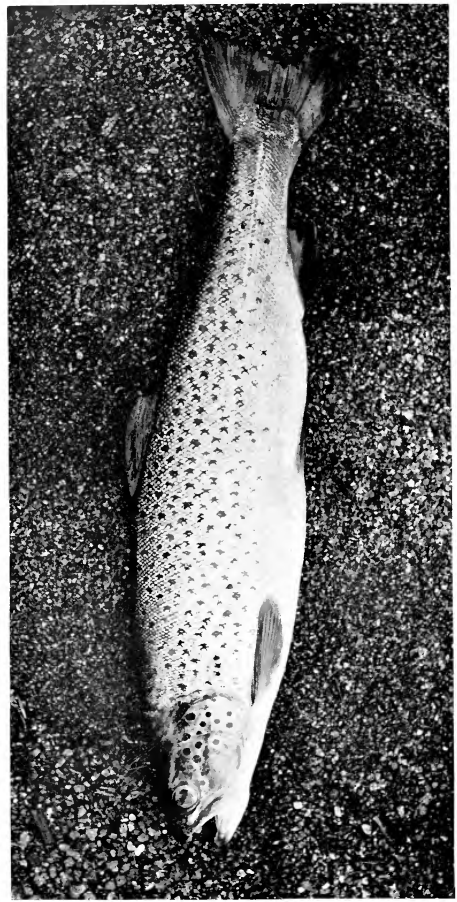


Fig. 196.—1-lb. Loch Slattell Trout, Sutherland. July 1900.

do, he turns round and rushes after them. Quite small trout are often seen behind the spawning-bed picking up the spawn that remains uncovered by the gravel. Trout after spawning become kelts (Fig. 195),

FIG. 197.—Loch Shattell Trout, Sutherland; average 1 lb. July 1902.

and soon thereafter return to the main stream, where they remain in the deep pools till March, when food is more plentiful. In April, when the flies begin to appear—blue duns first, and then March browns—they begin to leave the deep pools and come on to the shallow streams, where the flies are most abundant. At this time they often run up rivers for a considerable distance. In large streams they are generally in the best condition about the 15th of May, while in the smaller streams they are not in good condition till June; and, strange to say, in the south of England, on the Itchen, trout are not in good condition until

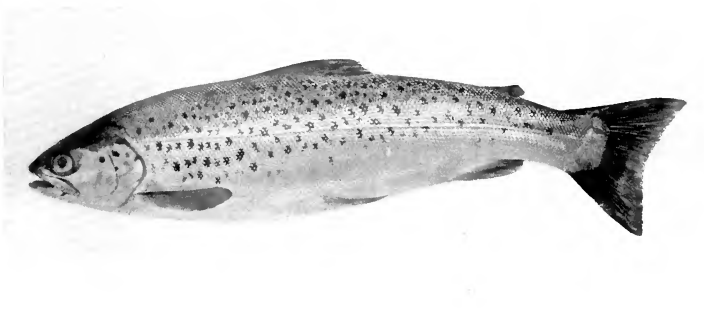


Fig. 198.—3-lb. Loch Crosophuill Trout, Sutherland. June 1900.

they have had at least a week's feeding on Mayflies, which is generally about the first week of June.

On nearly all the northern rivers there is an abundance of February reds, blue duns, and March browns. The March browns are nearly as large as Mayflies, and the trout feeding on them soon come into perfect condition. On many of the streams of the south of England no March browns appear. This is owing to the sluggish nature of the rivers and the want of round boulders in the bottom, of which the larvæ of the March browns are extremely fond. Their thin flat bodies appear to be adapted for whirling round the stones, which protect them from their enemies.

Flies bring trout into condition much quicker than the food they obtain on the bottom. A cold, backward season keeps back the

flies, thus preventing the trout from coming so soon into condi-

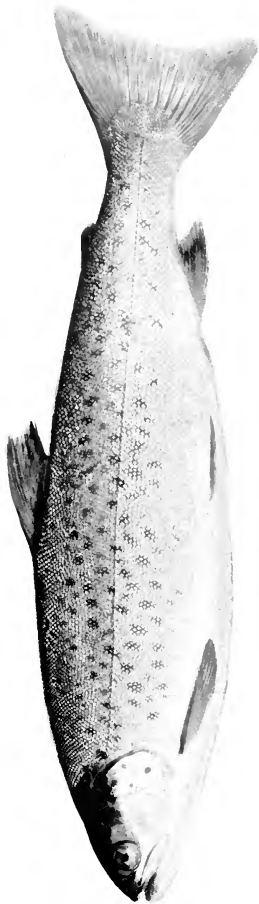


Fig. 190.—4lb. Loch Crosphuill Trout, Sutherland. June 1903.

tion. So much is this the case, that in a warm summer trout grow twice as much as they do in a cold one. The changes caused

by feeding have misled many naturalists, leading them to believe there are many different species of trout in this country.

Fig. 200.—5-lb. Loch Crosephuill Trout, Sutherland. June 1900.

As I have already said, I have studied this matter very carefully, and my experience all goes to prove that the changes are due to feeding.

FIG. 201.—$\frac{3}{4}$-lb. Loch Gorm Trout, Scourie, Sutherland. July 1904.

If one wishes to have "Loch Leven trout," all he has to do is to introduce some "burn trout" fry into Loch Leven, when they will

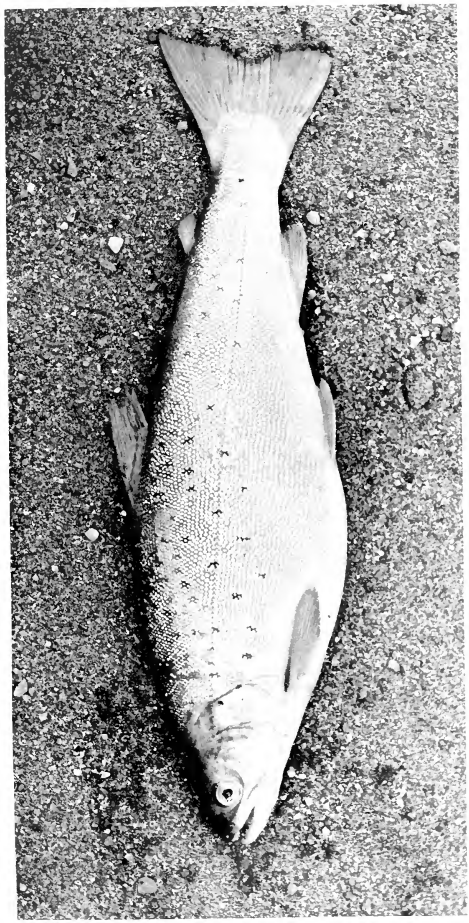


FIG. 202.—2-lb. Female Tidal Trout, the Estuary of the Tay. June 1902.

very soon have the appearance of Loch Leven trout. If half of the fry are allowed to remain and the other half transferred to a poor

hill-burn, after four years they will become "burn trout," weighing only $2\frac{1}{2}$ oz., while their brothers and sisters in Loch Leven will, after

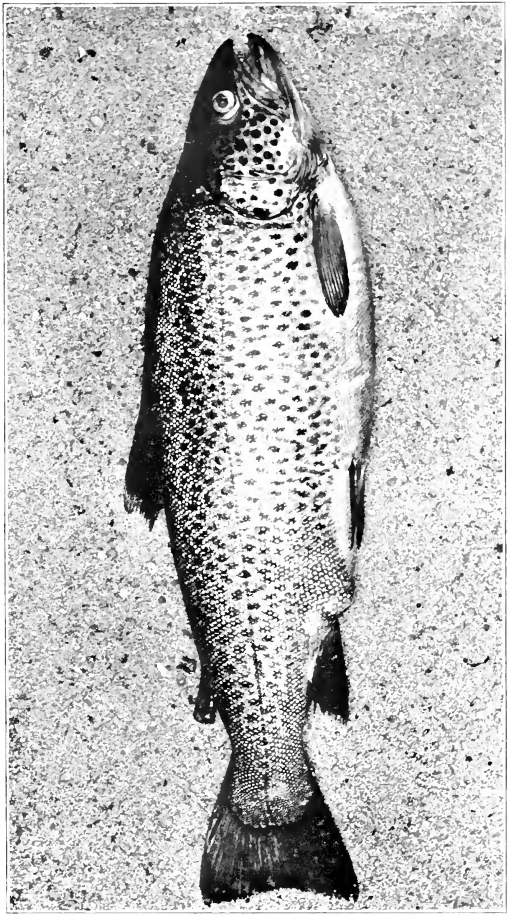
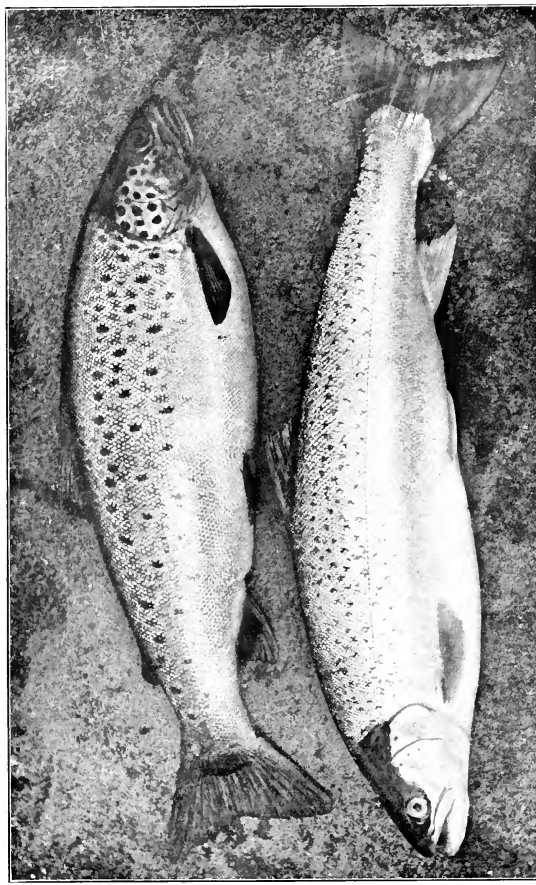


Fig. 203.—Gillaroo Trout, Loch Mulach-Corrie, Sutherland.

the same length of time, be 30 to 36 oz. in weight, and this, I maintain, is due to the feeding. The same difference will be found in a loch.

FIG. 204.—Loch More Trout, average 2 lbs., showing condition greatly improved by extended feeding area of loch. Caithness, July 1908.



(1) (2)

FIG. 205.—(1) Brown Trout and (2) Sea-trout, 1¼ lbs. each, from the Tay, showing the difference. 20th April 1908.

FIG. 206.—Loch Scye, Caithness, July 1902.

Fig. 207.—Loch Ballygill Trout, Melvich, Sutherland. July 1901.

Fig. 208.—Loch Hundland Trout, Orkney. July 1899.

If one part of the loch is deep and another part shallow, the shallow part will produce large trout and the deep part small trout.

Fig. 209.—¾lb. German Trout, 2½ years old.

Loch Ericht at Dalwhinnie is 16 miles long, and for 12 miles it has only shallow water for a few yards from the side; the remainder

being hundreds of feet deep. On these 12 miles of water the trout

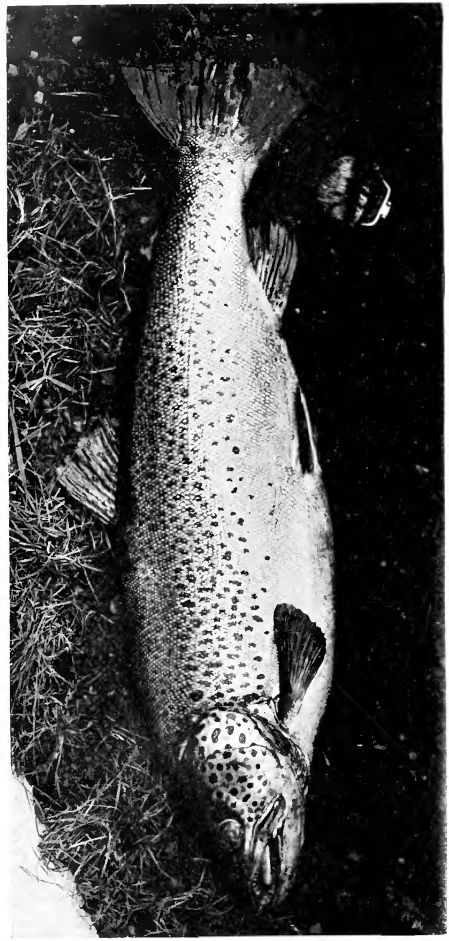


FIG. 210.—19½-lb. Loch Killarney Trout. April 1907.

only average about five to the pound; while at the shallow part at the west end they are nearly three-quarters of a pound. When a

loch is more than 12 feet deep the supply of food soon becomes scarce and the trout small, while shallow lochs produce plenty of food, therefore large trout.

The altitude of a loch, too, has a good deal to do with the size of the trout. Lochs 1000 feet above sea-level, fed from snow from surrounding hills, produce very little feeding until May, and owing

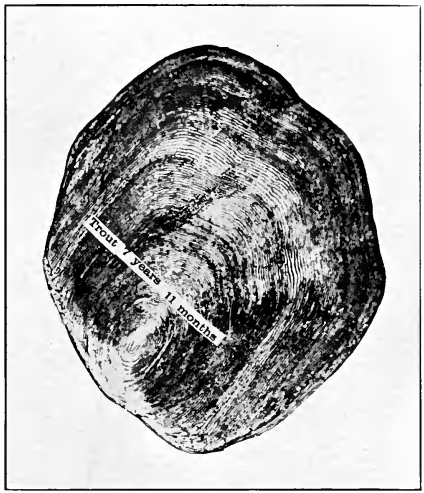


FIG. 211.—19½ lbs., Killarney. April 1907.

to the cold fall off in September, thus giving the trout only four months of good feeding. On the other hand, lochs at or near sea-level produce good feeding in March, and continue to do so till October, so that the trout have seven months' good feeding, or three months more than their Highland brethren. It will be seen, then, that this extra time for feeding, when extended over the seven or eight years which constitute the life of a trout, easily accounts for the difference in size. But not only is the feeding-time shorter, but the food is much scarcer. A loch at sea-level with water 5 to 12

feet in depth can usually sustain about two hundred trout to the acre, while one of the same depth at an altitude of 1000 feet will only produce food for half that amount. The owners of lochs usually pay far too little attention to this when stocking them, and in their management afterwards.

Large sums of money have been spent introducing Loch Leven

FIG. 212.—13 lbs., Loch Rannoch. 25th June 1906.

trout into lochs which contain small trout that are scarcely worth catching, in the belief that the size of the trout will be improved in this way. Instead, however, of increasing the size, those who do this are selecting the best possible means of defeating their object. The small size is caused by there being too many trout for the quantity of food in the loch. Reduce the number of trout and the size will very soon increase. This can be done by netting and curtailing the spawning-ground, or by fishing it well. It seems rather strange that those who have the care of lochs give them so little attention. One

often hears the complaint that, although such and such a loch did well for the first few years, it then began to decline, and the

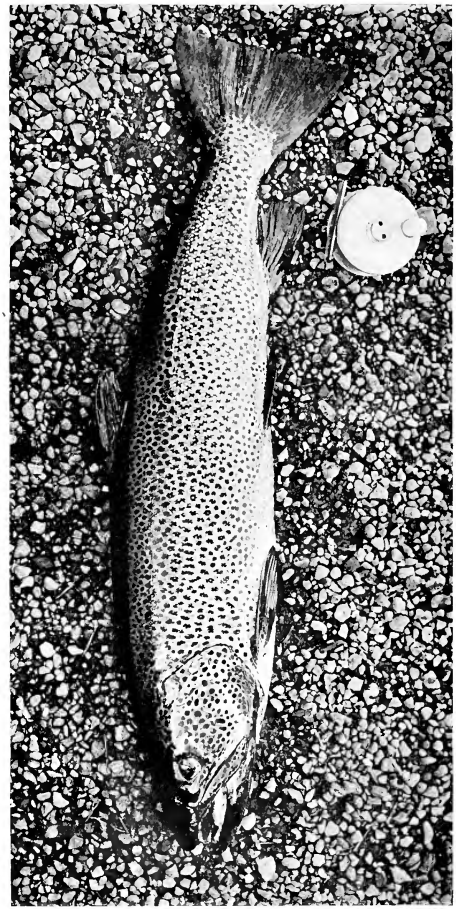


Fig. 213.—8-lb. Loch Ericht Trout. Caught 14th June 1902.

trout became so small that they were not worth catching. Now this is caused by their having too much spawning-ground, and as

a consequence, the trout became too plentiful for the quantity of food available.

FIG. 214.—10-lb. Loch Quoich Trout, Inverness-shire. July 1900.

A good example of this, although from a different cause, is found in the case of the famous lochs at Altnacealgach in Sutherland. Thirty years ago these contained trout six or seven to the pound,

and at that time were seldom fished. Now that they are more fished the trout average about two or three to the pound. Or you

Fig. 215.—7-lb. Loch Shin Trout, Sutherland. June 1900.

may hear another complaint that thirty years ago a certain loch contained plenty of trout, and yielded fine baskets of free risers, each

fish averaging 1 lb., but now the loch contains nothing but large trout

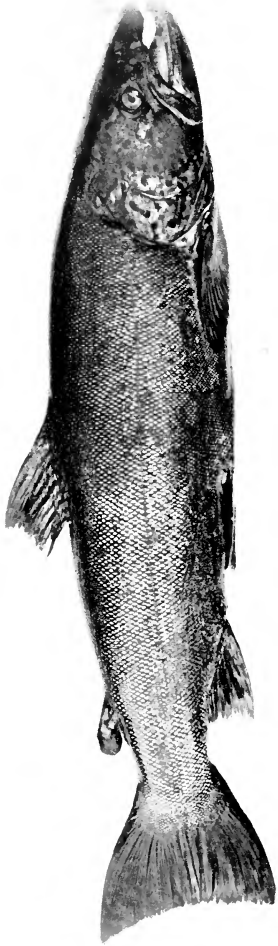


FIG. 216.—13-lb. Loch Rannoch Trout. June 1905.

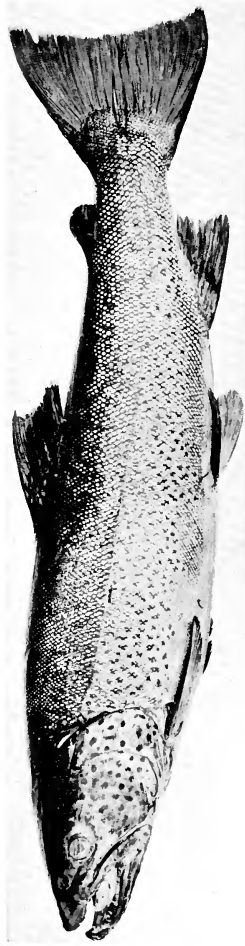


FIG. 217.—14-lb. Loch Rannoch Trout. June 1906.

of a sulky nature. In its early days sixty trout, weighing 60 lbs., were often caught in a day; but now it is most difficult to capture

more than three trout in a day weighing 6 lbs. The reason of this is not too much spawning-ground, but want of it; and if two hundred

Fig. 218.—13-lb. Loch Rannoch Trout. June 1903.

yearlings are put in to the acre, the "fine baskets" of the old days will come back again.

When a farmer rents a piece of land for grazing he knows how many sheep or cattle it will pasture, and that if he put on more than the proper number they will not grow. He also knows that if he introduce too few they will become fat and too lazy to eat up all the pasture, and he will thus lose part of the money paid for the pastureland. If the proprietor or the tenant of a loch would consider the matter in the same way as the farmer, he would obtain full value out of his lochs, be saved a deal of grumbling, and find life more pleasant.

For years I have had the management of several lochs, and

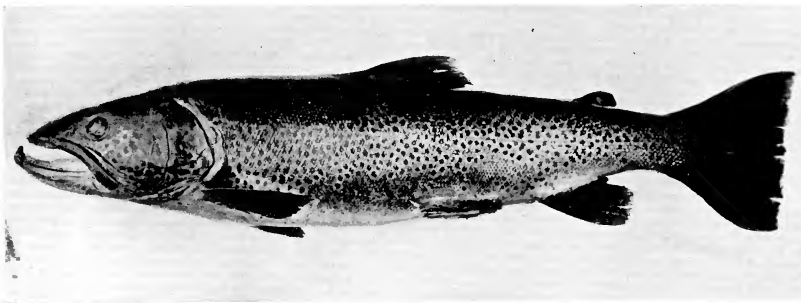


FIG. 219.—16-lb. Loch Rannoch Trout. May 1903.

when the trout grow too large and do not rise I introduce more trout, and soon the large ones begin to rise more freely. If, on the other hand, the trout are too small, I net them or deprive them of part of the spawning-ground. In constructing new lochs one should endeavour to have as much shallow water as possible, but not shallow enough to allow weeds to grow in it. The best depth is from 5 to 9 feet; beyond 12 feet food becomes scarce, and trout do not rise well in deep water. Attention to those matters will ensure the success of a loch and save much unnecessary expense.

The nature of the feeding has such an effect on the appearance of trout that no two lochs or streams in Great Britain contain trout which are exactly similar. My experience of hundreds of lochs and rivers

causes me to differ from those naturalists who say that there are

Fig. 220.—11-lb. Loch Quoich Trout. July 1906.

many species instead of only varieties of trout. Although Loch Leven trout are supposed to be a distinct species, I maintain that given a loch

producing the same or practically the same feeding as that found in Loch Leven little or no difference in the trout could be detected. The trout

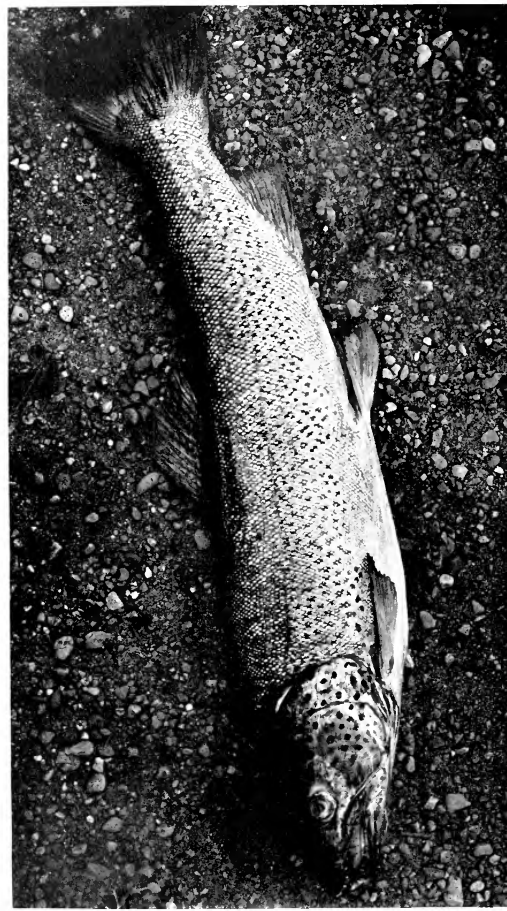


Fig. 221.—10-lb. Loch Quoich Trout. July 1900.

of Loch Slattell at Forsinard in Sutherland (Figs. 196, 197) are as nearly alike to those of Loch Leven as any I have seen. By comparing the

photographs of the former with those of Loch Leven it will be seen that they are almost identical. The rich feeding in Loch Leven produces spots on their sides. Loch Crosophuill in Sutherland contains rather

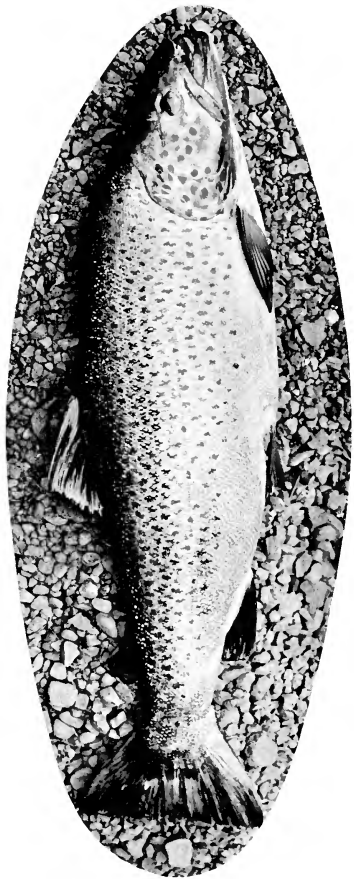


Fig. 222.—16-lb. Loch Rannoch Trout. June 1903.

better trout than Loch Leven, because the feeding is somewhat richer (Figs. 198, 199, 200); while Loch Durness, close to Loch Crosophuill, contains even richer trout, so rich that the spots on the sides become

joined together. A photograph is shown (Fig. 183) of a trout weighing 9 lbs. which was caught in this loch; this should be compared with

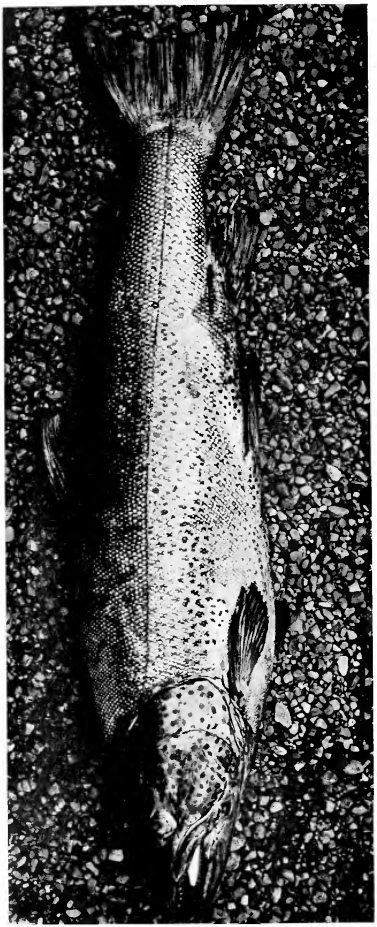


Fig. 223.—15-lb. Loch Quoich Trout. June 1901.

those of the Loch Leven trout. The other varieties of trout which are not so well fed should also be compared with these.

Loch Gorm trout (Fig. 201), for instance, nearly all have round black spots on their sides, and look almost like a different species. But these spots, as before, are the result of the special feeding in this loch. The feeding has also a great deal to do with the shape. The richer the feeding the smaller are the heads and the plumper the bodies. Then the nature of the soil and the colour of the water have much to do with the colour of a trout. Clear water and a light-coloured bottom produce silvery-coloured trout, while peat-

Photo by Harry Anderson.

FIG. 224.—8-lb. Loch Veyatie Trout. June 1906.

coloured water produce dark-coloured trout. Young trout before they spawn are brighter in colour than older trout. Trout, however, which live in tidal water which is brackish are nevertheless silvery like sea-trout, and present a strong contrast to Loch Leven trout. A photograph of a trout from the tidal waters of the Tay is shown in Fig. 202. The trout in Loch Harry in the Orkney Islands also frequent brackish water, and it is difficult to tell from their appearance whether they are sea-trout or brown trout.

Many trout become migratory because the streams frequented by them are not large enough to afford sufficient protection, hence on attaining a certain size they fall back into the sea. They must either

go into brackish water or into the sea. They thus become migratory, and may be seen in the streams during the spawning season in large

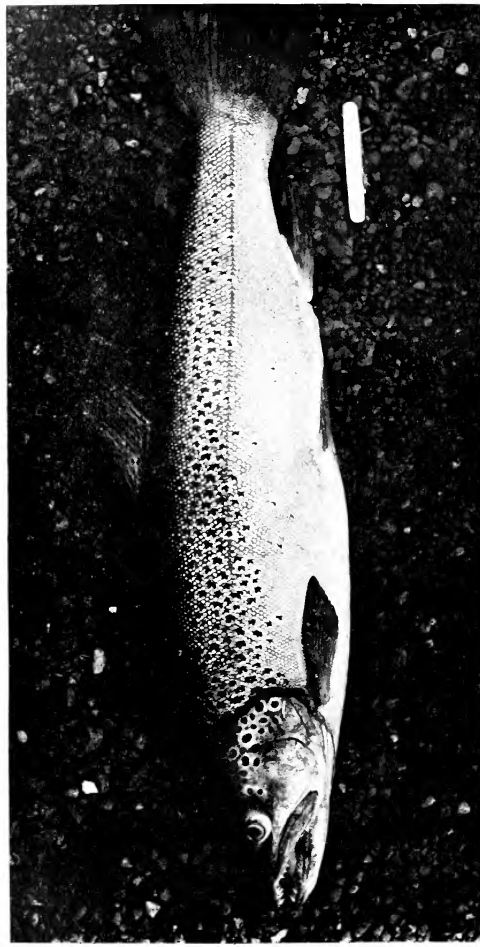


FIG. 225.—7-lb. River Dean Trout. July 1900.

numbers, many of them being 5 or 6 lbs. in weight. When they have spawned they return again to the sea.

In Loch Stenness, the chief of the Orkney lochs, the water is

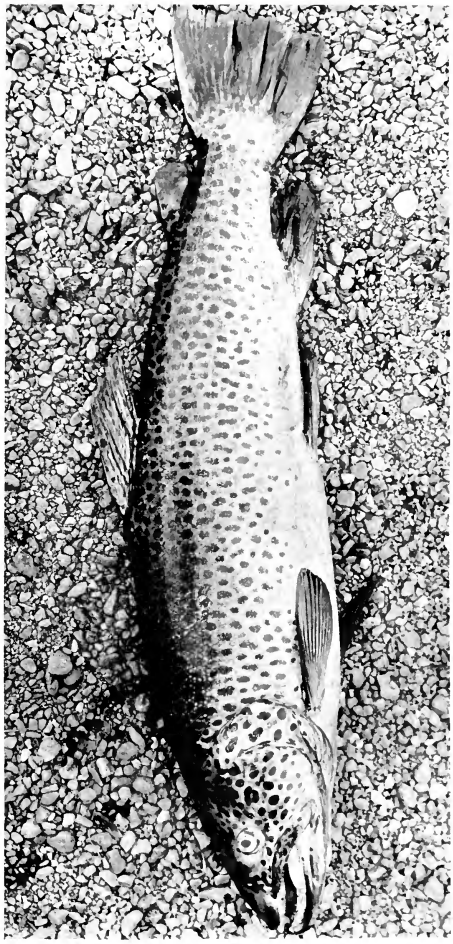


Fig. 226.—6-lb. Loch Veyatie Trout. July 1906.

always brackish, and contains many brown trout, which, owing to the splendid feeding ground, run to a large size. The finest I have

seen, and, I believe, the largest ever caught in this country, was sent

Fig. 227.—19-lb. Loch Rannoch Trout.

to me to be set up, and three days after capture weighed 29 lbs. I have noticed many trout from 10 to 20 lbs. in weight rising in

Loch Stenness, but these large ones are very difficult to catch. Having an opportunity of feeding all the year, they are always in good

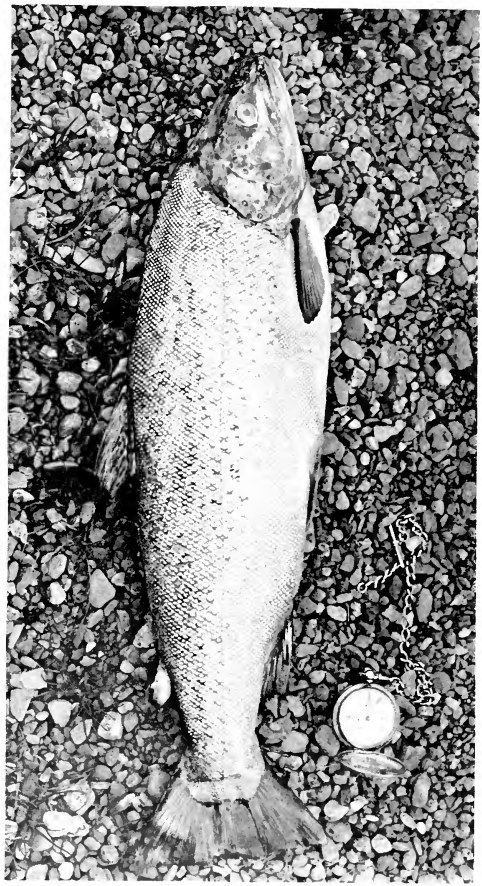


Fig. 228.—5-lb. Loch Crosophuill Trout. June 1902.

condition, and even the kelts are handsome fish. Loch Harry, which adjoins Loch Stenness, is also affected by high tides, and becomes occasionally brackish. So suddenly does the salt water come on that

the trout become sick and run up the streams. In July and August many of the smaller trout leave Stenness, run up into Loch Harry, and in both lochs are in good condition early in March.

The Gillaroo trout found in Ireland and in Scotland are considered a distinct species. But this is difficult to understand, as I have caught many of them and, although their shape and markings are different from those of most of the loch trout we see, the difference is all caused by the food in the particular loch in which they are found. If they were all cleared out and ordinary trout introduced, these latter would become "Gillaroo" trout in a very short time. See photograph of one from Loch Mulach-Corrie, Sutherland (Fig. 203).

The *Salmo ferox*

Many maintain that this is also a distinct species. I have caught many of these fish in the lochs in Scotland, and have had hundreds through my hands for preservation, therefore I have no hesitation in stating that a *ferox* is only a trout *Salmo fario*. Its great size is accounted for by the fact that it has become a cannibal and lives almost entirely on its own species. I have made a point of examining most of those I got in, nearly all of which contained from one to three trout and nothing else. Where there are plenty of trout to feed upon they grow so quickly that they may be 15 to 20 lbs. in weight in seven or eight years.

In describing the scales of trout I will try to prove their age. Trout of many shapes and colours are found in Loch Ericht, and when in good condition are shaped like a small salmon. In Loch Rannoch they are thickly spotted and yellow in colour. In Loch Awe some are silvery like a salmon; some have short heads, others long heads and large teeth, while no two of them are alike. For their size they weigh much more than salmon and far surpass them in strength. When hooked they fight to the last, often escaping after they are in the net or on the gaff. See photographs of them from various lochs. They are usually caught by trolling with artificial

minnow, but the most successful bait is a small trout. It is best to have one rod mounted with a phantom and another with a small trout trolled between the deep and the shallow water. I have found that they take best on a dull and fairly rough day. They are now so much sought after, however, that a good deal of patience is required to catch one, and blank days are the rule.

Many of the lakes in Ireland contain large *ferox*. A photograph of one I got in this season is shown (Fig. 210). It weighed 19½ lbs., and was a real beauty. The flesh of these large trout is usually well coloured and almost like that of the salmon, but not so good for the table, as it is coarse, almost like that of a bull-trout.

LOCH LEVEN TROUT

MUCH has been said and written about the Loch Leven trout, the general belief being that it is a distinct species. Again, it is maintained that it is a landlocked sea-trout, but I fail to see how this can be, because a sea-trout could not become landlocked so long as there was an outlet of over 30 feet wide through which it could escape. Fish have always had free access to the sea from Loch Leven, so that they are no more landlocked than those in Loch Tay. The reason, no doubt, for stating this is, that in 1830 the loch was reduced to about three-fourths of its original area, but it seems to be forgotten that this made no difference in the quantity of water flowing out of the loch. Of course, had the fish been prevented by hecks from going down there might have been some reason for this assertion.

I have had ample opportunity of studying Loch Leven trout, and nothing I have noticed about them has caused me to think they are different from any other trout. Loch Leven trout are admitted by all to be the finest trout in Great Britain, if not in the world, and nowhere can they be seen to such perfection as in Loch Leven. Loch Leven is almost round, and covers an area of 3400 acres, in which are several islands, the largest being St. Serf's, occupying about 80 acres. According to Sir John Murray and Mr. Pullar's survey, it is 350 feet above sea-level. "The area of the bottom between the shore and the 10-feet contour line is about 1430 acres, or forty-two per cent of the whole area of the loch; that between 50 and 70 feet is nearly 110 acres." No less than eighty-five per cent of the bottom is covered by less than 20 feet of water.

This large extent of shallow water is the means of producing a

large amount of food. The loch is supplied with water by four large

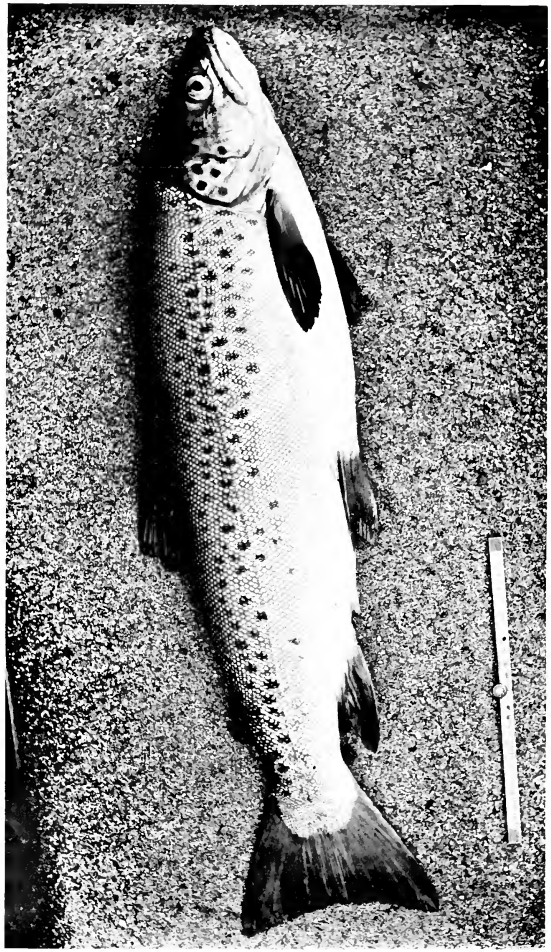


Fig. 229.—3-lb. Male Loch Leven Trout. Loch Leven, June 1903.

streams, the principal ones being the North Queich, the Gairney, the South Queich, and the Pow. Each is about 2 miles from the

other, and the outlet being at the east end, all help to keep the loch fresh and healthy. The North Queich and the South Queich

Fig. 230.—2½-lb. Loch Leven Trout. Caught in Loch Leven, June 1905

enter on the west side, the Gairney on the south, while the Pow enters on the north.

Besides these four principal streams, many other smaller streams and springs contribute their share, and the whole uniting in one body become the source of the river Leven. For several miles from the outlet the river contains trout as large as there are in Loch Leven itself; but below this the river is so much polluted with poison that even the eel fry are killed. The chief food of the trout is the larvæ and flies of the blood-worm, which begin to appear early in April, and are usually most numerous about the 20th of that month. They first make their appearance within 2 miles of the outlet—from Duncan's corner to the sluices; and also in that part of the loch between the sluices and the "Narrow Neck," including the "Hole of the Inch."

The larva of the blood-worm, which lives in the mud, is about an inch long, blood-red in colour, and about the thickness of a stocking needle. In April the perfect insect often retains the blood colour of the larva. There are several varieties, but this is the principal one. Hundreds of Loch Leven trout which I have opened from April to September contained both larvæ and flies of the blood-worm. The larvæ of this fly have the power of rising to the surface and falling to the bottom again, and while in this state trout devour large numbers of them. In my opinion, the most important food of the trout in Great Britain, though little known to anglers, is the fly and larva of the blood-worm. One can have little idea of the immense swarms which appear on Loch Leven unless they have personally witnessed this wonderful sight. As the season advances more appear in the evening than during the day, and on warm nights the surface of the water is almost covered with them, and it is then the trout are to be seen "boiling" all over the loch.

Next in importance is the olive dun, both the fly and larva of which are greatly sought after by the trout. It is one of the Ephemeræ, and usually makes its appearance about the beginning of May, and continues till the middle of October. There is both a large and a small kind. Besides the trout, gulls, terns, and swallows feed largely upon them. The trout also obtain part of their food-supply from stone-flies, caddis-flies, and their larvæ, also a small fly, Cain, one of the smaller

Ephemeræ. At certain seasons, too, they feed on shellfish, which are very plentiful over the whole of the loch, and in August they feed much on perch fry, which then appear in the loch.

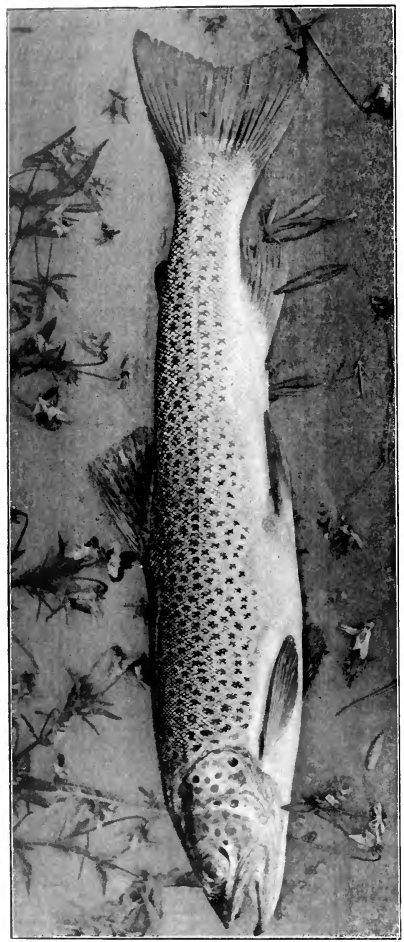


Fig. 231.—Loch Leven Trout going back, 4 lb., same length as one 3 lbs. July 1908.

About the middle of September trout that are to spawn begin to take less food, while the younger fish that are not to spawn feed on until the cold weather comes, when they also begin to leave off feeding.

Loch Leven being at an altitude of 350 feet above sea-level, is pretty cold, and in some cold seasons the trout are not in good condition till the middle of May. June, however, is the month in which insect life is most prolific, and as a consequence the trout are then in perfect condition. Had Loch Leven been nearer sea-level, the trout would have grown to a larger size. Their limit of size may be said to be about 3 lbs., although frequently trout from $3\frac{1}{2}$ lbs. to 5 lbs. are captured. The record for Loch Leven stands at 10 lbs.; and on 8th September 1911 Col. Scott, Callander, captured with fly a beauty

of 9 lbs. 13 oz. Such monsters are, however, rare, the great majority dying on reaching 3 lbs., when they will be from seven to eight years old. A large proportion of those on growing to 3 lbs. fall off in

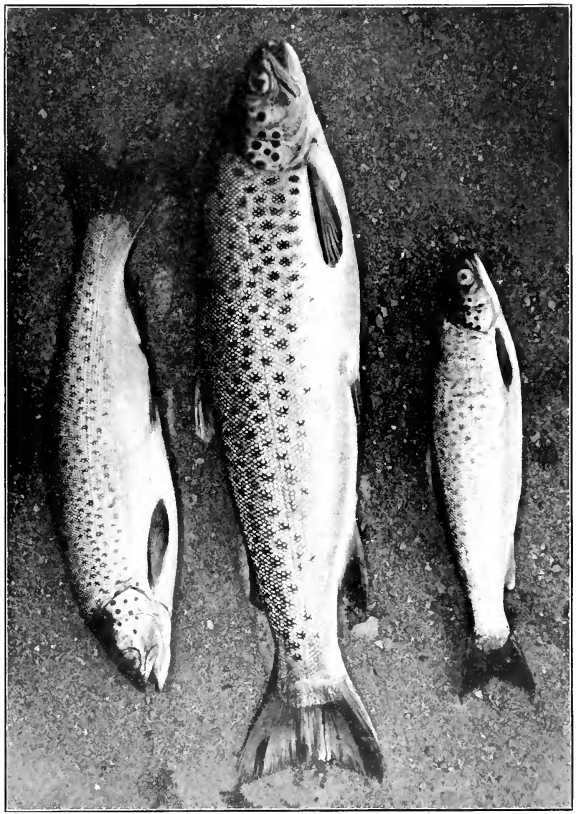


FIG. 232.—Loch Leven Trout. Largest, 4 years and 4 months, 2 lbs. Second, 3 years and 4 months, 1 lb. Third, 2 years and 4 months, ½ lb. Loch Leven, July 1908.

condition, decrease in weight, and ultimately die when reduced to three-quarters of a pound. An illustration of one is shown (Fig. 231), but many of them are reduced even more than this one. If Loch Leven trout have better feeding and a longer time to feed each year than

they have in their native loch, they grow to a much larger size. When they have been transferred to New Zealand, for example, many have reached 20 lbs. and over.

FIG. 233.—Loch Leven Trout. Male, 2 lbs.; Female, 1½ lbs. Loch Leven, June 1906.

Those wishing to stock their rivers would do well to see that they are supplied with genuine Loch Leven trout, for many of the trout from hatchery establishments have short gills and deformed fins,

and are therefore not fit to stock any water. Such trout do not feed well and remain dwarfed. The better able a trout is to swim quickly through the water, the more food it will be able to catch.

In April, when feeding on flies, Loch Leven trout travel through the water at the rate of about 2 miles an hour, their speed gradually increasing till July, when it reaches about 3 miles an hour. They travel from 6 to 18 inches under the surface, sucking down one fly after another, and usually heading upwind. Their habits, however, are different in a stream. They usually choose a certain spot and remain there, often rising for weeks at the flies floating down. This is why dry-fly fishing is practised on streams. The angler sees a fish rise, and casts his fly almost over the ring it made; did he do this on a loch the trout would be yards away by the time his fly alighted, and would not see it.

During cold weather the trout leave the shallows and go into deep water, where they remain during winter. When spring comes they begin again to seek shallower water, where food is more plentiful. Trout in Loch Leven $2\frac{1}{4}$ years old usually weigh about 8 oz.; $3\frac{1}{4}$ years, 1 lb.; $4\frac{1}{4}$ years, $1\frac{1}{2}$ to 2 lbs.; $5\frac{1}{4}$ years, 2 to 3 lbs.; 5 to 7 years, $2\frac{1}{2}$ to 5 lbs. (Fig. 232). After this, as has already been said, most of them die. The condition of the trout depends much on the weather in April and May, and if seasonable at all are soon in good condition; again in a cold spring I have seen them in better condition in the middle of April than they sometimes are in the middle of May. These two months, however, have generally more effect than other months in bringing trout into condition, both in Loch Leven and other lochs as well. In Loch Leven the young trout which have not spawned are usually about $\frac{1}{2}$ lb. in weight during the winter, and are in much better condition than those that have spawned and become kelts (Fig. 233), consequently it is usually the smaller trout that come first into condition. The trout that spawn early come into good condition much quicker than those that spawn late, so that there are trout constantly coming into good condition from April to the end of August. The largest ones are

usually the last to be in good condition. After the end of August they begin to become lean and to lose colour again. When in best condition a Loch Leven trout is generally as well coloured as a salmon, and is as highly prized for the table. Even the pike, perch, and eels in Loch Leven surpass all others that I have seen, thus testifying also to the richness of the feeding. Many years ago the loch was said to contain large char, but these are now extinct. Besides trout and other fish, the loch also supplies food for thousands of duck. There are tufted ducks by the thousand, and large numbers of black-headed gulls. The latter, along with numerous swallows which appear early in April, live principally on the flies that are bred in the loch.

Loch Leven trout begin to spawn in October, but it is not till about the middle of November that they do so in large numbers. The North Queich is the earliest river, and the Pow the latest. In the North Queich the trout run a month earlier than those in the other streams. Trout remain for some time in the larger streams before they are ready to spawn. In the smaller streams, on the other hand, they often begin spawning the day they enter them, and return to the loch again as soon as they have done so. The male trout run up first.

The operation of spawning can easily be observed on the smaller streams. A trout of 2 lbs. weight makes a bed 10 to 15 inches long, and from 6 to 12 inches deep. The female, as a rule, takes two days to complete the process, and then falls back into the loch again, while the males remain for several weeks. After the fry are hatched they remain in the streams from nine months to two years before entering the loch. Those in the streams have red spots, but after they have been a short time in the loch the red spots disappear. This is peculiar to Loch Leven. They then become quite silvery, and retain their silvery coat until the spawning season arrives. As they grow older there is more yellow in their colour.

At one time Loch Leven was netted and the fish sent to market, where they produced a high price, and no doubt they would sell at a

much higher rate now. For the last thirty-five years, however, the loch has been reserved for angling, and during that time has had

Fig. 234.—Basket of Loch Leven Trout. Loch Leven, June 1906.

many ups and downs, success or failure depending on the number of pike in the loch. When these were plentiful they soon reduced the

number of trout, but now fortunately these "pests" have been destroyed, and during this year—1908—the number of trout caught has far exceeded the catch of any previous year, for over 34,000 trout were caught with the rod, and with attention and care this famous loch is capable of yielding even a much larger annual catch than this. When we consider the large extent of the loch—3400 acres—we hardly think that it is too much to expect an average of only a little more than nine trout to the acre, especially when we have known a loch to produce fifty trout to the acre.

THE GRAYLING

THE Grayling is not so plentiful in Scotland as it is in England. It is found in a few of the Border streams, and in the rivers Clyde and Tweed grayling are very numerous. The farthest north river in which it has established itself is the Isla in Perthshire. This river swarms with them, and they are the finest grayling I have seen, the average weight of those I have caught here being over a pound. Many of them, however, are from 1 to 3 lbs., and sometimes over. So plentiful are they that when fishing for pike on one occasion our men brought ashore twelve dozen in one haul of the net. No doubt, in the course of time, this will be one of the most famous places for grayling in Great Britain. The river is a very large one, and is in many places from 60 to 90 yards wide. It is deep, flows smoothly, and has a mud bottom and plenty of food which suits their taste. These grayling were introduced at Kenmore about thirty years ago by Lord Breadalbane. The Tay being too rapid a river, no doubt led them to seek more suitable quarters, and some had found their way into the quiet waters of the Isla, where they are now fairly established. Grayling spawn about April, and are not worth catching until August or September, although October and November are the best months. Their flesh is white, and when in good condition is quite good for the table. They rise freely to fly, but are more difficult to catch when in good condition. A small dry fly is usually the most successful lure, and in cold, frosty weather a small red worm does well. Although one may sometimes get "here and there a lusty trout, and here and there a grayling," where grayling increase in numbers trout diminish accordingly.

The Grayling

With its large dorsal fin standing out prominently from the centre of its back the grayling can be easily recognised from all other fish. The mouth is very small and specially suited for sucking up worms, caddis larvæ, and the larvæ of Ephemeræ, upon which the grayling feeds. When in the pink of condition, which is usually about the middle of October, it is a very beautiful fish. Below the lateral line the sides and belly are quite silvery, while above this it becomes a golden olive, merging into a dark slate colour on the back. The head is also of a dark slate colour, while an occasional one is to be met with having a few dark spots near the gill-cover. Specimens I have had from the Itchen in Hampshire were more spotted and very much coarser than our Isla grayling. As the spawning season arrives much of the silvery appearance is lost, and they become of a darker colour all over. Grayling, like salmon, are very subject to disease, which carries them off in large numbers.

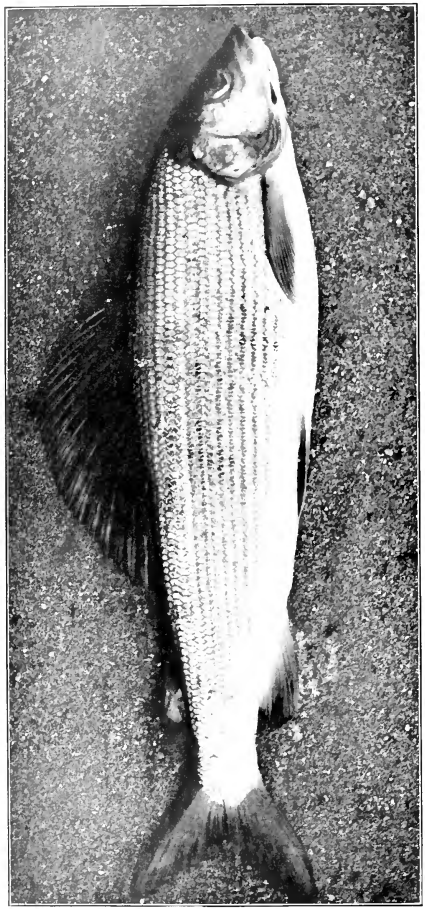


FIG. 235.—2-lb. Grayling, from the River Isla, Perthshire. October 1908.

Fig. 236. Grayling from the Ish.

THE CHAR

FROM the angler's point of view char are inferior to trout. They are fairly well distributed over Scotland, England, and Ireland, and are only found in lochs or lakes, except in the spawning season, when they run up rivers to spawn. They are much more local in their habits than trout, swimming mostly in shoals, and usually frequenting the quietest bays in the larger lochs, while in smaller lochs they roam over that portion where food is most abundant. They often grow to 12 oz. or 1 lb., but the great majority average about four to the pound. The largest I have seen was caught in Loch Ericht, and weighed $2\frac{1}{2}$ lbs., although as a rule in this loch they are seldom got over a quarter of a pound. This large one, however, may have been a different species, as it was much lighter in colour than the ordinary ones.

While fishing for trout in the Gaick Lochs near Kingussie I caught many weighing from a half to three-quarters of a pound. In Loch Tay they run about three to the pound. In the lochs at Altnacealgach there are many small char, while in the Baden Lochs in Sutherland they also run small. At Scourie, on the west coast of Sutherland, again, some of the lochs contain large char. Some I caught here and sent to the British Museum were new to natural history, and have been named after the donor. In appearance they are somewhat like sea-trout, being silvery and having very little red on them. The heads are small and the bodies thick. A description of them is given below by Mr. Tait Regan of the British Museum, who is at present working at the British char with considerable success.

Salvelinus Mallochi

Depth of body, $4\frac{1}{2}$ in the length; length of head, $4\frac{1}{3}$ to $4\frac{1}{2}$ (♂) or

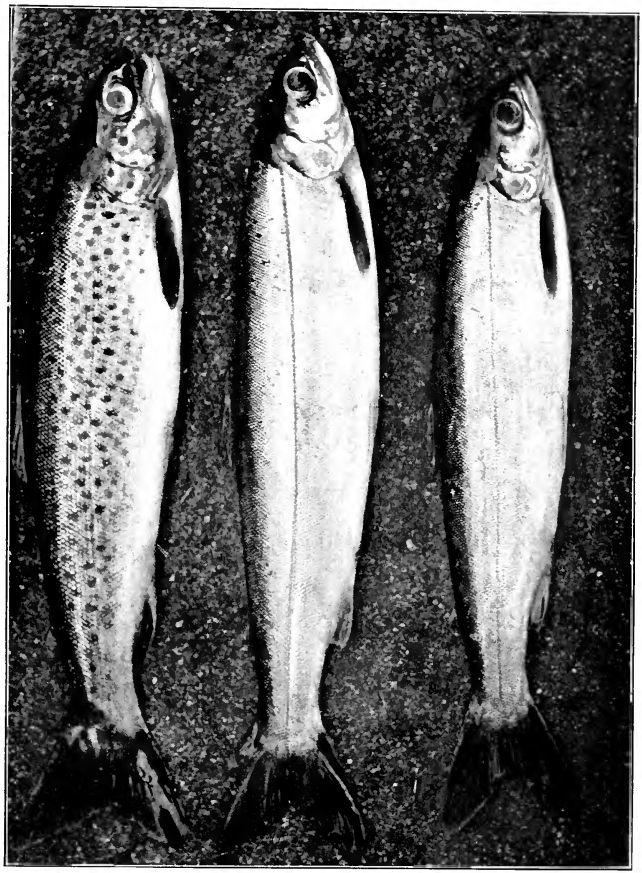


Fig. 237.—One Brown Trout, two Char, ¼ lb. each. Loch Baden, Sutherland, July 1908.

$4\frac{3}{5}$ to $4\frac{4}{5}$ (♀); snout obtuse, longer than the eye, the diameter of which is $5\frac{1}{2}$ to 6 in the length of head. Interorbital region convex, its width 3 to $3\frac{2}{5}$ in the length of head. Dentition moderate, lower jaw a little

shorter than the upper; maxillary extending nearly to below the posterior margin of eye or a little beyond, its length $2\frac{2}{5}$ to $2\frac{2}{3}$ in the length of head; lower jaw obtusely pointed anteriorly, its length $\frac{3}{5}$ to $\frac{2}{3}$ of the length of head; 9 to 11 branchiostegals, 13 or 14 rather slender gill-rakers on the lower part of anterior arch, 188 to 200 scales in a longitudinal series; dorsal with 10 branched rays, its origin nearer to the top of the snout than the base of caudal, the longest ray $\frac{1}{2}$ to $\frac{3}{5}$ the length of head, extending $\frac{1}{2}$ to $\frac{3}{5}$ (♂) or a little less than $\frac{1}{2}$ (♀) of the distance from its base to the base of pelvis; heart depth to caudal peduncle $1\frac{3}{4}$ to 2 in its length and $\frac{1}{3}$ to $\frac{2}{5}$ the length of head; slate-coloured above, whitish tinged with orange below, numerous pale spots covering the back as well as the sides. Habitat, Scourie, Sutherlandshire (see Fig. 238).

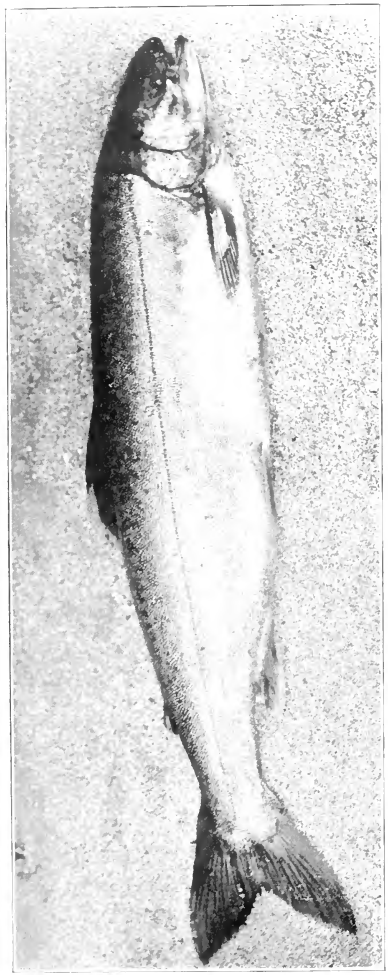


Fig. 238.—$\frac{3}{4}$ lb. Malloch's Char. Scourie, Sutherlandshire.

The best time to fish for char is on quiet evenings, when they can sometimes be seen rising to small flies. The angler's flies should be allowed to sink and then drawn quietly along. They readily take a small

white or Silver Devon. The common char is very beautiful when

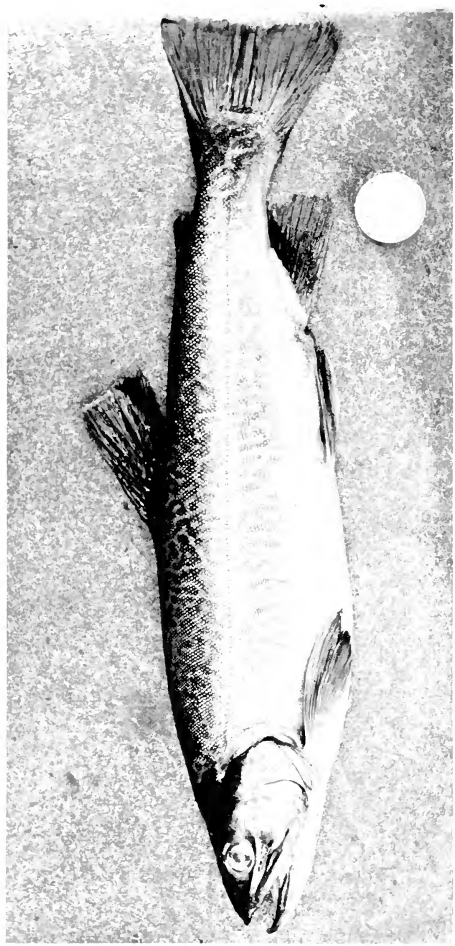


FIG. 239.—2 lb. *Salmo fontinalis*. The Tay, June 1904.

in good condition, being of a bluish-purple colour on the back, while its sides are of a golden tinge running into red on the belly. There

are red, white, and black spots along the sides as well as on the tail and dorsal fin. The fins are reddish pink, and the outer edge is tipped with white. Altogether it is a very beautiful fish. Little use is made of them in Scotland, although they are excellent for the table. At Windermere they are caught in nets, and when preserved are sold at a higher price under the name of "Potted Char." If, however, all these pots were examined carefully, many of them would be found to contain small trout instead of char.

At one time Loch Leven contained char of a large size, many of them weighing 2 to 3 lbs., but they are no longer found there. No doubt the lowering of the loch accounts for this, as they would be pushed on to the shallows during a storm and the wind would drive them ashore as it does the perch. After a storm I have seen the shore strewn for miles with perch. Char run up the rivers to spawn in October, and the process of spawning is the same as that of the trout.

Another char, *Salmo fontinalis*, or American char, has been introduced into this country during the last thirty years, but up to the present time I do not know of any place where they have established themselves. They seem to do so for a time in lochs, but usually soon disappear. They are very handsome fish, and closely resemble our own char.

THE PIKE

(*Esox lucius*)

THE pike is distributed over Great Britain and Ireland. Many of the lochs and rivers in Scotland contain fine pike, but they are seldom fished for. In England and Ireland, however, they are much more sought after. The smaller ones weighing from 2 to 3 lbs. are called Jack. The spawning time comes on in March, at which time they approach the shore and attach the spawn to reeds and branches of trees, where it remains until hatched.

By the end of August, if the feeding is good, they are half a pound in weight, and in another year weigh about 2 lbs. After this, if they can procure plenty of food, a rapid increase in weight soon takes place. Their principal food consists of living fish that frequent loch or stream; nothing comes amiss, not even members of their own species. Where trout and the young of the salmon can be got they prefer them to any others. They will even swallow frogs, ducks, waterhens, rats, or any other living thing that appears on the water.

I have had occasion to net pike on the river Tay and its tributaries, for the purpose of reducing their number, and on many occasions I have found them stuffed full of smolts and parr. The destruction thus caused must be very great, and when allowed to increase in a stream or loch trout very soon disappear. In streams they take up their abode in quiet corners, and remain perfectly still, watching for a trout to come within reach. When it does so they dart after it with great rapidity, and if the unfortunate trout gets

between their jaws there is no escape. Down it goes head first, to be followed by others as fast as captured. At night they leave

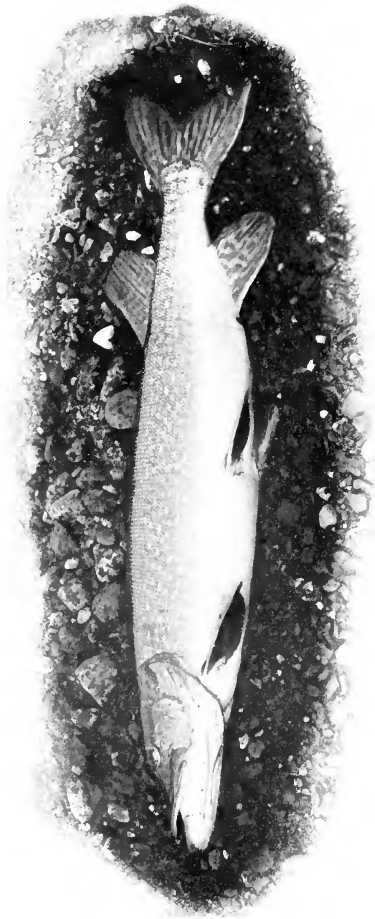


Fig. 240.—18-lb. Pike (*Esox lucius*). River Earn, February 1900.

their hiding places in the deep pools, come out on the shallows and range about after trout, but when daylight comes, like guilty beings,

they fall back again into the deeper pools. Their movements are performed so quietly that it is difficult to know whether they are in a pool or not. They are also very difficult to net, for if the bottom of the river be full of mud they will sink into it and allow the net to pass over them. If there is no mud they keep near the surface and watch what is going on, and so keep clear of it.

Two large pike used to frequent a pool on the river Earn below a weir, which was regularly netted, but the pike always escaped capture. I have often watched their movements from the top of this weir. If they were near the side I was on, and I stood opposite them, they at once moved quietly away, keeping within a foot of the surface and proceeding sideways often for a distance of 60 yards. As soon as I went out of their sight they gradually returned to their favourite haunts. When once disturbed they act so warily that it is very difficult to catch them with a sweep-net. A drift or hang net left in the water during night suits the purpose better.

During hot weather, in summer, many pike frequent shallow water and bask in the sun. Here they can easily be shot. In lochs which contain nothing but pike attempts to reduce their number often defeat the end in view, for only the large ones are captured, and the small ones are left without fear of being molested by their larger brethren. Owing to the small price obtained for pike in the market they are not worth keeping for profit. Those found in stagnant lochs are not at all palatable, whereas those caught in clear lochs and rivers where food is abundant are usually quite good. One often hears of very large pike being caught, but as far as I can learn no pike has been caught in this country during the last forty years whose weight has exceeded 45 lbs., and very few have been caught 35 lbs. in weight.

THE PERCH

(*Perca fluviatilis*)

THE perch is distributed generally over Great Britain, and is a very handsome fish. Its back is olive-coloured, the sides yellow, the belly white, and there are six well-defined dark bands along the sides. The dorsal fin, the chief weapon of defence, has twelve spines, which often draw blood from the unwary angler's hand. Below this is another dorsal fin without spines. The ventral, anal, and tail fins are tipped with scarlet. The scales are large and hard. The gill-cover is also hard and bony and ends in a sharp point, which is also used in defence. The flesh of the perch is excellent.

Perch as a rule proceed in shoals and frequent quiet parts of a river. Few are found in quick-running rivers. In many lochs they simply swarm, and if food is plentiful, grow to a large size. The largest I have ever seen came from a small loch in Cambridgeshire, and turned the scale at 5 lbs. In Scotland they seldom exceed 3 lbs. in weight, the average weight in many lochs being about 1 lb. They spawn in May and are very prolific. The ova, like that of the pike, is attached to branches and weeds. By the middle of August the perch fry are about an inch long and sport about in large shoals. Trout and other fish feed much upon them, and I have frequently caught trout whose stomachs contained many perch fry. It is interesting to watch trout devouring these fry. One's attention is usually drawn to them by seeing a number of terns dive down into the loch, and on approaching the scene of action one sees the surface of the water all eddying and swirling with trout chasing

the fry and making such slaughter and commotion that anglers call it "Waterloo." So numerous are they that when the angler casts his flies among them he usually hooks two or three large trout at the first cast, and so eager are they in pursuit of their prey that many cause themselves to be foul-hooked. Not only is the number of perch reduced in this way, but vast numbers are destroyed by storms. Shoals of them in shallow water are driven ashore during a gale. Shortly after the great storm which blew down the Tay Bridge I had occasion to be shooting on Loch Leven, and found the

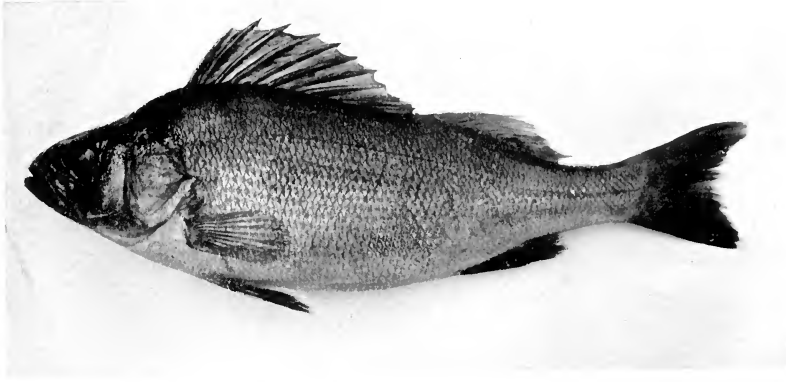


FIG. 241.—2-lb. Perch (*Perca fluviatilis*). River Earn, February 1900.

shore to the width of about 100 yards, and extending for several miles, strewn with dead perch, undeniable evidence of the destruction caused by wind and waves. For years after this they were not nearly so plentiful as formerly. Perch are in best condition from September to the end of December.

The perch is not at all a shy fish, and it will take almost any bait. A young friend of mine on one occasion when fishing for perch had used all his worms. Tearing a strip of red wool from one of his garments, he fastened a small piece of it to his hook and continued to bring the perch ashore almost as frequently as he had done with

the live bait. When one drops his bait among a shoal of them he picks them out very rapidly. Proceeding in shoals they are easily netted, and I have seen hundreds taken at one draw of the net. The finest specimens to be got in central Scotland are caught in Lindores Loch. I have seldom got them here less than 1½ lbs., and on many occasions from 2 to 3 lbs. in weight. In the "Loch o' the Lowes" near Dunkeld, too, are some very large perch. Large ones are also to be found in the river Isla and the river Earn, but they are seldom fished for. Perch thrive in stagnant water where trout could not live.

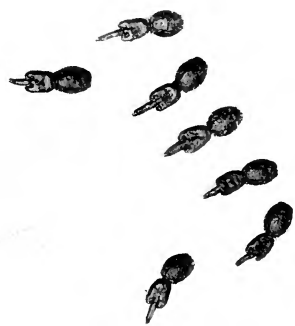


FIG. 242.—Sea Lice. Life size.

THE TENCH

(*Tinca vulgaris*)

TENCH are not so widely distributed as the perch, but they are found in many lochs. In Scotland they are difficult to catch and are not often seen. They prefer weedy lochs to more open water. Those that are swept from the lochs into our quick-running rivers soon disappear. In no river that I know of in Scotland have they established themselves. It is said that pike will not eat them.

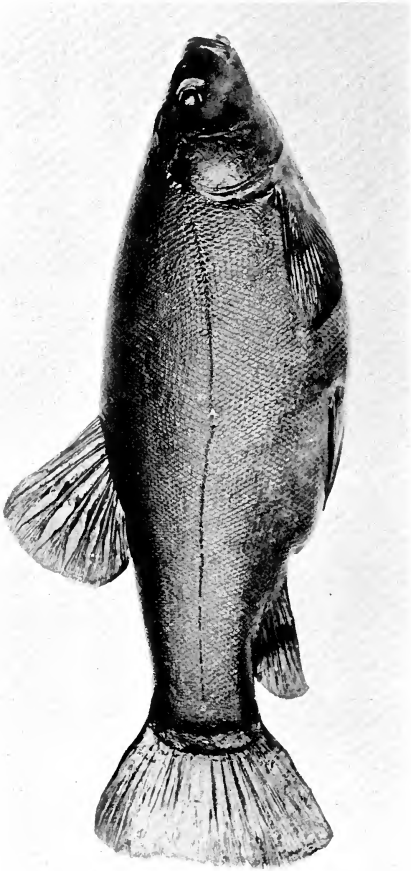


Fig. 243.—5 lb. Tench.

THE STICKLEBACK

(*Gastrosteus aculeatus*)

THE illustration given (Fig. 244) is the natural size of the three-spined stickleback. There are said to be several kinds, but the above is the one which is most plentiful all over Scotland. Every stream, river, and ditch contains them, and they are also got in the sea all round our coasts. They spawn in June, but before doing so a rough nest is made, in which the female deposits her eggs. These are hatched in from twenty-one to twenty-five days. While the eggs are in the nest the male becomes very brilliantly coloured. His belly is scarlet, his sides silvery, and his back yellow and green; the female, on the other hand, is usually of an olive green. He then keeps a strict watch over nest and eggs, and allows no intruder to come near.

By December the young are about three-quarters of an inch long. I have on many occasions kept them in a glass globe along with minnows, but the sticklebacks always killed the latter. The usual mode of attack was to swim close up to the minnow with fins spread out and to dash at it sideways, using the hard spine in striking. The minnow slipped out of reach for a moment, but the stickleback renewed the attack in the same way three or four times, after which the minnow fell lifeless to the bottom of the glass. The greatest number of sticklebacks I have seen was at the outlet of Loch Leven. Here they are drawn through the sluices, and being unable to re-enter the loch, the water at this part literally swarms with them.

If a new loch is made or an old one enlarged these interesting

little fish are soon found in great numbers in them. More especially is this the case if the loch is understocked with trout. One loch which I made was simply alive with sticklebacks for about 20 feet all round, but when I introduced a few thousand trout the number of sticklebacks was very soon reduced. Their favourite haunts are the backwaters of streams, the sides of lochs among weeds, small ponds, and ditches.

Fig. 244.—The Three-spined Stickleback.

THE MINNOW

(Leuciscus phoxinus)

The minnow is said to belong to the carp family. It is found in all parts of Great Britain. They are usually from $2\frac{1}{2}$ to 4 inches

Fig. 245.—The Minnow.

long, and where not too plentiful and food is abundant sometimes grow to 5 inches and weigh as much as 3 oz. In a pond near Perth they grow to a large size and are shaped like perch. They are found both in lochs and streams, and roam about in shoals. In warm weather they proceed up streams for long distances, and spawn in June. A gravelly stream is selected, where great numbers collect together; the stream often appearing quite black with them. As the spawning season approaches they assume a variety of colours. Some of them are black with white dots, others red, and others dark olive. Before the spawning season they are usually

olive on the back, silvery on the sides, and white on the belly. Minnows make excellent spinning bait for trout and salmon; and are often used alive for perch, which take them freely. During the summer months trout make great havoc among them, as they come on to the shallows at night and devour large numbers.

THE COMMON EEL

(*Anguilla vulgaris*)

THE eel has a wide distribution and, wherever there is water, is found all over Great Britain. Some say there is more than one species, as one has a sharp nose and another a broad nose. Professor Grassi explains this by stating that the sharp-nosed eels are the males and the broad-nosed ones the females and immature males. According to Professor Grassi, the eel does not arrive at maturity until it is five or six years old. If this is the case there must be a very great difference in the weight of eels of the same age, because many of them migrate when under 1 lb. in weight, while others are from 1 to 6 and even 8 lbs.

The eel fisheries of Ireland are of considerable value, one bringing a rental of over £2000. Where food is plentiful eels grow to a large size. In Loch Leven they often weigh 6 or 7 lbs., and I have known them to exceed this weight in the river Tay. If they are prevented from going to the sea they live to a good old age. I know of one in a small pond which looked quite 10 lbs. ten years ago, and is still alive and manages to frustrate all attempts to capture it. The pond in which it lives contains small perch and the largest minnows I have ever seen.

The eel fry come up all our rivers in countless thousands, distributing themselves over every stream and loch in Great Britain. They appear in the Tay about the 20th of April, when both sides of the river to the width of about 10 yards are crowded with them. In their movement upwards on a quiet day they make a ripple like that

caused by wind blowing along the surface of water. At this time they are from 3 to 4 inches long. The migration continues for about a fortnight, during which nothing seems too difficult for them to surmount. If the rush of water is too strong for them, they wriggle up the side among the wet grass. On one occasion a large stone had fallen out of the side of a bye-wash and left a large opening, which on examination was found to contain a living mass of eels. I put a pitcher underneath it, stirred up the eels, and withdrew the pitcher full of them, while many others made good their escape. At this time whitling, sea-trout, and brown trout gorge themselves with the young elvers. After the young fry pass up (Fig. 247) older eels from 6 to 30 inches long continue during the whole summer to advance higher up. I have proved this on many occasions by shutting off the water from mill-wheels and finding eels wriggling below in great numbers. They run most during the night. On the 1st of August last year I had occasion to watch the water passing through a sluice at Loch More. The force of the water was so great that the eels were unable to push through, and at midnight the pool below the sluice was a seething mass of eels of all sizes up to 30 inches long, but as soon as the sun appeared in the morning none were to be seen, all having fallen back into the pools below.

Fig. 246.—The Common Eel (*Anguilla vulgaris*), 6 lbs. Loch Leven, September 1900.

The migration to the sea usually takes place in September and October. A dark, wet, windy night is their favourite time, when they collect in great shoals, thousands of them sometimes crowded together. I have often seen them during the winter come from under stones and from holes in dykes when the water was let off mill-lades. Many of these were 2 feet long. The eel has little difficulty in finding food, as most larvæ live under stones where the eels hide. Eels, too, are very destructive to young salmon, for they devour large numbers from the fry up to the smolt stage.

FIG. 247.—Young Eels. July 1909.

There is no better bait for a large eel than a parr or a smolt, and if one is cast into a pool where there are large eels one of them soon picks it up. I have often fished during the night with natural bait, and if it was warm and thundery, eels were so eager to take the bait that I have had to leave the pool I intended fishing. In Scotland eels are allowed a free passage to and from the sea, as there are no eel fisheries and few people try to catch them with the rod. In most, if not all, eel fisheries they are only caught during the downward migration, but I am of opinion that if eel fishers were to try to catch them during their upward migration a continuous supply could be obtained from May to October. In all our large estuaries swarms of eels could be found during the summer months, for they are constantly running up. It seems to me that, besides the migration of the elvers, there is a continual migration inland of eels of a larger size, which swim along the bottom and across the whole width of the river, and

on this account escape detection. This is certainly a matter well worth investigating.

To catch the eels on their downward course and allow them to escape on their upward is not a wise procedure, for by the time they are going seawards they have done all the damage they can do, while if caught on their upward progress a marketable size two or three years old could be got. This arrangement would prevent an enormous destruction of salmon fry, for I consider the eel by far the greatest enemy that salmon and trout have. The young of the salmon hide under stones during the winter, and an eel after a fish is like a ferret after a rabbit—it can not only go wherever a trout can go, but its body remains concealed under a stone, with only its mouth and its eyes exposed to view. There he lies in wait for any living thing that comes near him.

Not until April 1906 was it known where eels spawned. Professor Grassi, of Rome, discovered the breeding-ground to be out in the Atlantic Ocean from Norway, Denmark, France, and Spain, in some parts 1000 miles from shore, at a depth of 560 fathoms, with the eel larvæ 50 to 100 fathoms overlying this depth. The generic name "Leptocephalus" was applied to the eel larvæ before their history was known.

The Leptocephalus develops from the egg, grows to the length of about 3 inches, then ceases to feed until the metamorphosis is complete and the little fish has become an elver. These larvæ have perfectly clear ribbonlike bodies, which are as transparent as glass, and free from colouring, except in the case of the eyes, which are black. Their length is about 3 inches and their breadth three-eighths. The metamorphosis takes place in four stages, and when complete the length is reduced to about $2\frac{1}{2}$ inches, and the width to a little more than one-eighth. When in the sea they are known as glass elvers, but on arriving in fresh water pigment is developed in the skin and they are now known as elvers. The times of migration to our shores vary very much. In some localities it takes place in December, and in others not till April. In the Shannon district it is as early as

January, while in the Tay district it is about the 20th of April. On 12th June 1909 I saw large numbers of eel fry running up the Tay and side streams, which run lasted well into October. I also noticed them running up the river Allan, a tributary of the Forth, during November. The Forth District Fishery Board have lately erected a fish-pass here, and during a recent visit I found the river in flood. Owing to a part between the fish-pass and the existing bank of the river not having been properly filled in, hundreds of eels got up into this and could proceed no farther. The superintendent and I measured a number and found them to be about 9 inches in length. There is little doubt that this is the average length attained during their first season. Of course there may have been others of a larger size lurking in the pools below, waiting for more favourable conditions, but none came under our notice.

RAINBOW TROUT

(*Salmo iridens*)

THESE trout were introduced into this country from America over twenty years ago. As time went on they were thought to be much superior to the *fario* as sporting fish. They may be so in their own country, but our climate does not seem to suit them. In a few English rivers they have done fairly well, as also in Blagdon Lake. If left to themselves for a year or two, however, I think they would all disappear. I have had ten years' experience of them in Scotland, and have introduced them into many lochs. They did well for three or four years and weighed about $1\frac{1}{2}$ lbs.; but after that we saw few of them. Some of them spawned, but never in sufficient numbers to establish themselves.

Great care must be taken when introducing rainbow trout into a new loch, as most will make good their escape in a few days unless prevented from so doing by means of a heck or other obstacle. They also appear to have excellent memories, for if once hooked and returned to the water you seldom get a second chance of hooking him. Another drawback is that they spawn in April and May, and are not worth catching until well on in the season. It is therefore not advisable to have trout and rainbow trout together in the same loch. The best way to do with rainbow trout is to stock a loch with two-year-olds, and fish for them the following year. If the feeding is good, three-year-old fish should be from 1 to $1\frac{1}{2}$ or even 2 lbs. in weight. In reservoirs where they cannot get out they grow to a large size; we have some here from 7 to 10 lbs. When in proper condition they are very good for the table.

FIG. 248.—7-lb. Rainbow Trout, six years old, caught near Perth. September 1906.

Rainbow Trout

Rainbow trout are so named because the colours of their sides resemble those of a rainbow. They can be easily distinguished from a trout, both by their colour and the greater number of spots (see Fig. 249). In New Zealand, where they have rich feeding, they grow to over 20 lbs. and rise to fly. It is strange, however, that in this country when they become 2 lbs. or more in weight they seldom rise to a fly. When hooked they jump out of the water like sea-trout, and fight well to the last.

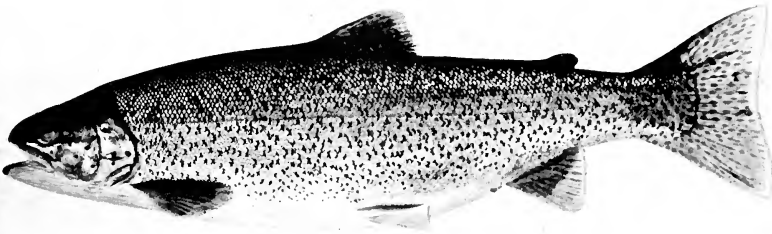


FIG. 249.—2-lb. Rainbow Trout, four years old, caught at Battleby Loch. August 1904.

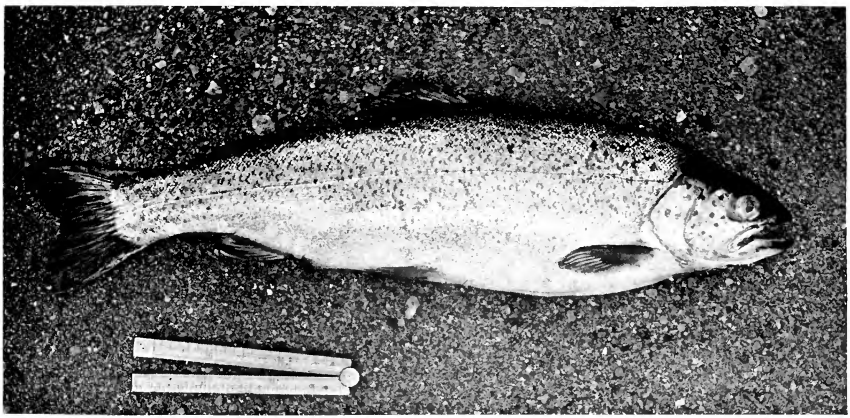


FIG. 250.—1-lb. Rainbow Trout, two years old. Loch Dupplin. May 1904.

FIG. 251.—2-lb. Deformed Brown Trout, caught in the Tay. May 1904.

MONSTROSITIES

One's curiosity is often excited by the capture of a deformed fish. The causes of malformation are not well known, and are difficult to

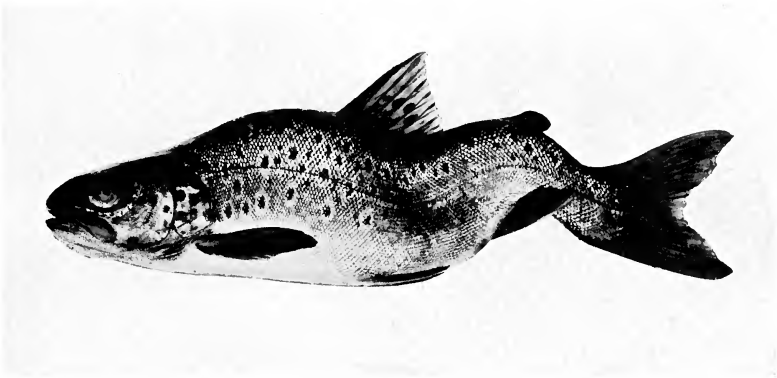


Fig. 252.—½-lb. Deformed Trout, caught in Loch Clashfern, Sutherland. July 1904.

account for. I show photographs of a few of those I have seen. I am of opinion that many of these malformations are caused by starvation. Lochs that are overstocked and in which the spawning-ground becomes too prolific, and lochs in which the trout are in poor condition and do not grow to more than 3 or 4 oz., contain many deformed trout.

In Loch Clashfern in Sutherlandshire I have captured three or four monstrosities in one day. Many deformed trout may also be seen coming from the hatcheries, having double heads, deformed heads, defective fins, and short gills. These defects, of course, have an injurious

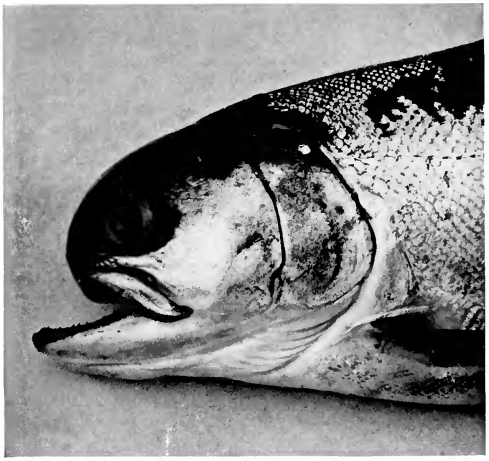


FIG. 253.—1½-lb. Deformed Sea-Trout, caught in the Tay. July 1907.

FIG. 254.—Deformed Trout, caught in the Tay. May 1904.

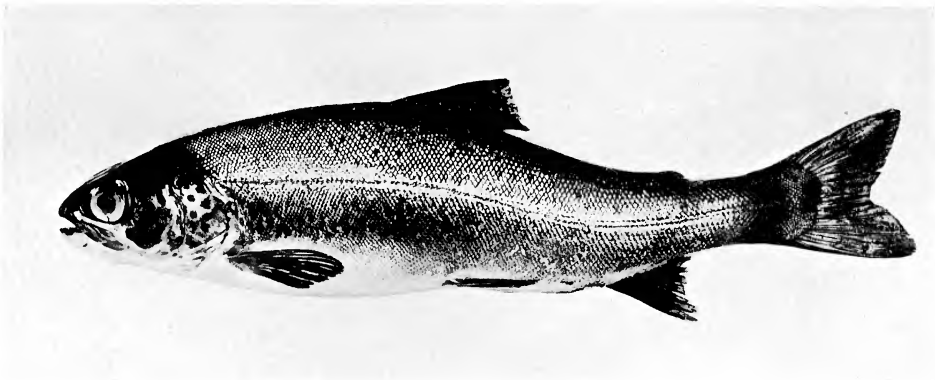


FIG. 255.—½-lb. Deformed Trout, caught at Tomdoun. July 1904.

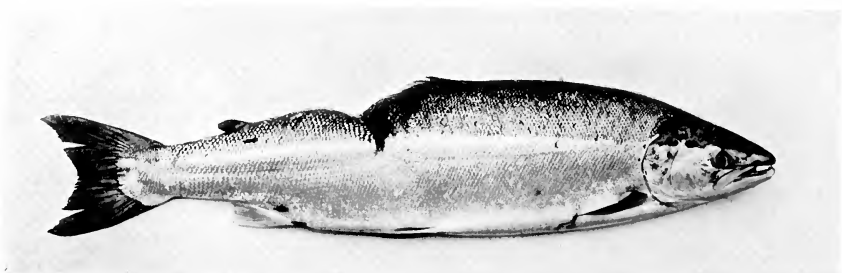


FIG. 256.—5-lb. Deformed Grilse, caught in the Tay. July 1905.

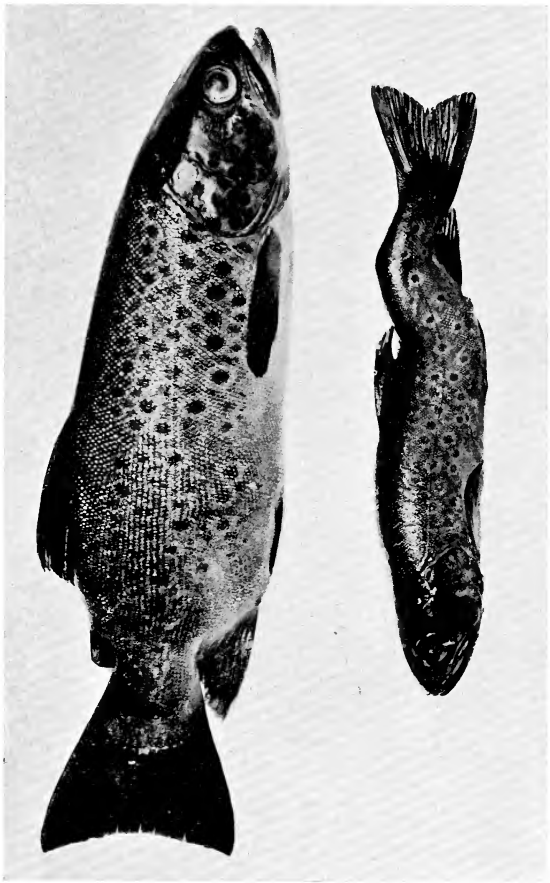


FIG. 257.—Deformed Trout, caught in Cleshfern, Sutherland. July 1904.

FIG. 258.—2-lb. Deformed Trout, caught at Scourie. July 1904.

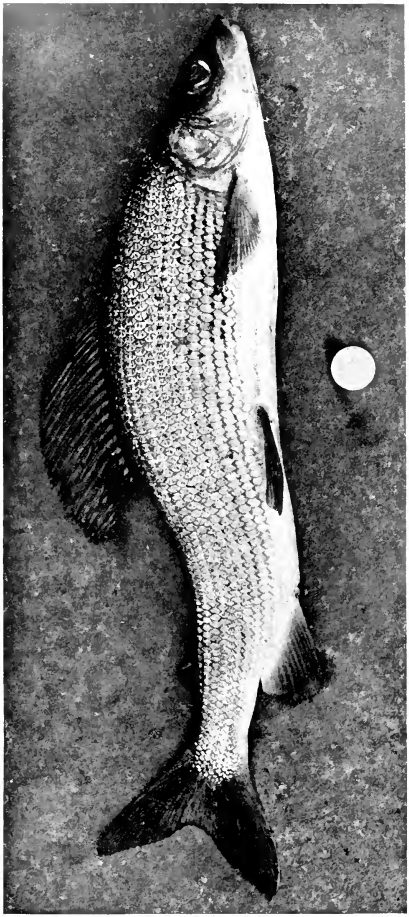


FIG. 259.—1½ lb. Deformed Grayling, caught in the River Isla. October 1908.

effect on the growth of the fish all through its life. In hatcheries overcrowding would seem to be the cause of these malformations. Deformed trout, however, are also found in rivers and lochs where overcrowding is impossible and food plentiful, so that deformities may be due to other causes, such as injury to the eggs or fry (see Fig. 251). Many deformed trout are found similar to this (see Fig. 252). Such deformity could scarcely be caused by injury to the eggs or fry. It points more to want of development, and very likely the parent would

FIG. 260.—2-lb. Deformed Trout, caught in Loch Dupplin. December 1907.

have a similar short head. The twisted backs may be caused by a weak spine. There are fewer deformities among salmon and sea-trout than among trout. Perhaps they may not be able to survive in the sea, and die off. Hundreds of salmon are found with so great gashes in them, made by seals and other enemies, that it is a wonder they manage to live. These injuries often heal up, but one can always note their effect on the fish, as they retard growth, causing them to become thin and of inferior condition. Many monstrosities are seen in the salmon hatcheries. Some of them have two heads, while sometimes two are joined together, as we occasionally see in the case of beasts and birds. As a rule these fish die when about six weeks old. When deformed fish are discovered they should be destroyed.

HYBRIDS

THERE is not the least doubt that in nature many hybrids are to be found. Sea-trout may often be seen spawning with grilse, and

FIG. 261.—1-lb. Zebra, cross between American Char and Loch Leven Trout.

trout with sea-trout. These being so much alike, it would be almost impossible to tell whether the offspring were crosses or not. Sir James Maitland carried out many experiments at his Howieton Fisheries in crossing brown trout with salmon, char with salmon parr, American char with Loch Leven trout. The latter cross he called a "zebra." See illustration of one bred in Howieton Fisheries (Fig. 261). This fish was light scarlet on the belly and had peculiar markings along the side, as shown in the photograph. For a description of these experiments I refer the reader to *Day's British and Irish Salmonidæ*. If these experiments have done nothing to improve the breed of fish, they have at least proved that crossing is possible.

VENDACE

(*Coregonus vandesius*)

This fish is only found in Loch Maben, Dumfriesshire, and is said to be so delicate that it dies as soon as taken from the water, and cannot be transferred to any other loch. No angler has yet been able to catch one with a hook, and they are usually caught with a sweep-net. The flesh of the vendace is considered a great delicacy, so great that many years ago a number of gentlemen arranged to meet and "feast" on what were caught. It is not known whether all the vendace in the loch were eaten up or not, but no such "feast" has again been held. These fish are now so very scarce that it was with difficulty I obtained the specimen illustrated on page 278. This specimen is now in the British Museum. It measured $7\frac{1}{2}$ inches in length, which is much above the average size. The colour of the back is light green, while the sides are silvery white. The tail is well forked, and the dorsal, pectoral, and anal fins are long and pointed, thus giving the fish greater power in swimming through the water. Perhaps the reason for their not taking a bait is that they only feed on minute crustacea or daphniæ, which are inhaled along with the water while breathing.

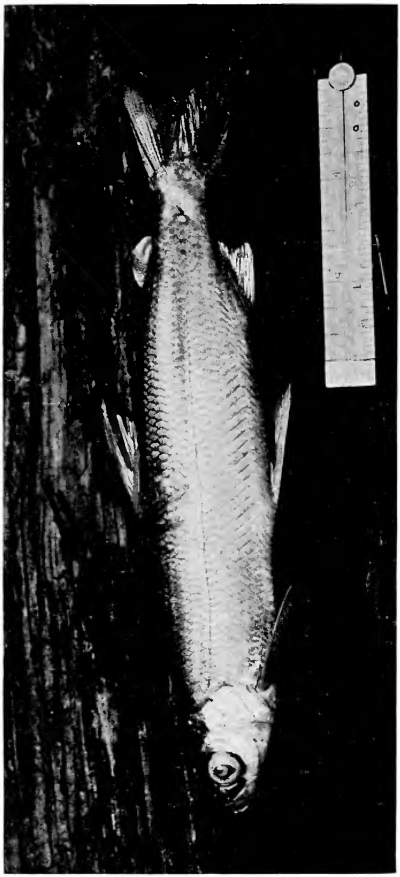


FIG. 262.—¼-lb. Vendace. Loch Maben. June 1904.

GWYNIAD

This is another fish very like the vendace, and is found in England and Wales. Some of the lakes in Cumberland contain them. The specimens I have seen from Derwentwater average about 8 inches long. Mr. Tait Regan of the British Museum mentions this fish as being closely allied to the vendace of Loch Maben, although it is by no means identical. From the photographs, however, it would be difficult to tell the one from the other. The colour and shape are like those of the vendace, and the fins of both are also alike. They are seldom caught with a hook, and little is known about them.

Fig. 263.—Gwyniad, caught by H. Anderson, Esq. Ullswater. 1904.

THE POWAN OF LOCH LOMOND

(*Coregonus clupeoides*)

Powan are found in large numbers in Loch Lomond, and are said to attain to the weight of 2 lbs. None of the specimens I have seen, however, weighed more than 1 lb. The powan is a beautiful fish. The head and back are light olive brown, and the fins light slate colour. The scales above the lateral line are well defined in eight rows, while below the lateral line to the anal fin there are also eight well-defined rows. The scales are silvery like those of a grayling, and the belly is white and covered with scales. The eyes are very large, and the upper edge is on a level with the head. The centre of the eye is black and is surrounded by silver, while the side of the head is like burnished silver intermingled with irradiating pink colour. The number of rays on the fins are as follows: the dorsal eleven; the second none; the pectoral seventeen; the anal ten; the ventral ten; the caudal twenty. The specimen figured was 12 inches long, and weighed three-quarters of a pound. Like all the others I examined, its stomach was full of daphniæ. This is their principal food, although I have occasionally found them to feed on the larvæ of the blood-worm. The scales are like those of the salmon, except that the rings continue right round. The rings are well defined, showing that the feeding has been rich. From the number of rings I make the age of the specimen shown to be four years.

Powan are rather coarse for the table. Large numbers are netted in Loch Lomond and sent to the markets, and occasionally they are caught by the angler. Loch Lomond is of vast size, 24 miles

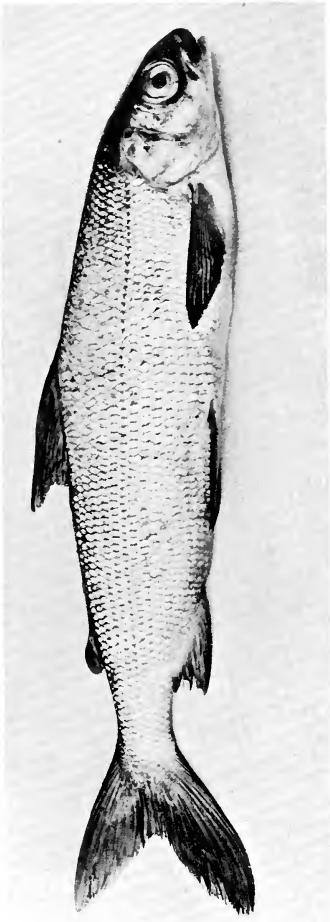


Fig. 264.—The Powan.

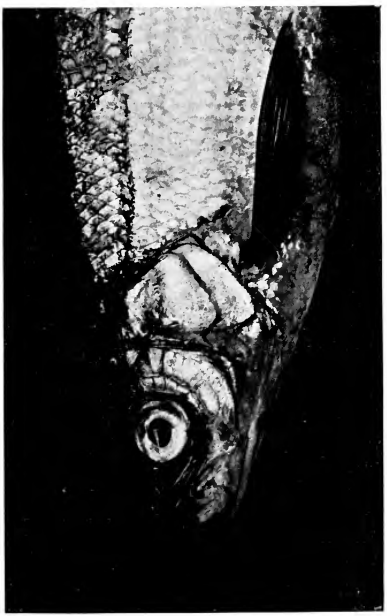


Fig. 265.—Head of Powan, life size.

long by 5 miles wide at its greatest breadth, and contains twenty-four islands, some of which are very large. It is thus a perfect breeding-place for crustacea, and there being so little run on the loch, they are not carried away. In this respect it resembles a town's reservoir with screens at the outlet so fine that daphniæ cannot pass through, with the result that inside the reservoir is a mass of insect life, and trout brought among them have only to open and close their mouths to get enough food to sustain them and make them grow to a large size. See photograph of daphniæ taken from the stomach of a powan (Fig. 266).

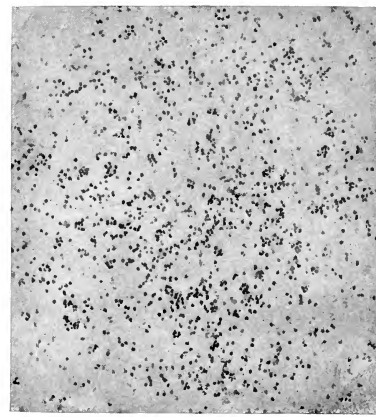


Fig. 266.—Daphniæ, life size.

THE FLOUNDER

(*Pleuronectes flesus*)

The freshwater flounder or fluke inhabits all the rivers in Great Britain except those that have barriers or those into which it has not been introduced. The usual barriers which prevent their ascent are waterfalls, weirs, and strong currents. The shape of the flounder makes it ill-adapted for surmounting obstacles. The moment they rise from the bottom of the stream the rushing water takes hold of them, and they are washed down. I have never seen flounders in rivers that have weirs with a gradient of one in twelve. The greatest number are found in estuaries of rivers and in lochs. The flounder is not at all particular as to what it eats, and can be caught with almost any bait. In fresh water they are usually caught with worm. Salmon net-fishers catch them all day long, the greatest number in the rising tide. The eyes are very large and are placed on the right side. The belly also is on the right side, which is peculiar.

Once when catching flounders in the river Tay a wag asked me if those I had were Tay flounders or Earn flounders. After looking at them he said they were all Tay flounders, because their eyes were all on the right side; therefore, on ascending from the sea, they could not see the Earn, as the latter joined the Tay on their left. The eyes placed in this position enable the fish to see all round it, even when flat on the ground. The eyes enable it, also, to change its colour according to the nature of the soil it is resting on. This changing of colour goes on continually from dark to light, and from light to dark, all "in the twinkling of an eye." When the fish

moves from the dark to the light the eye conveys the impression to the brain, which in turn sends it on to the cells all over the back, and

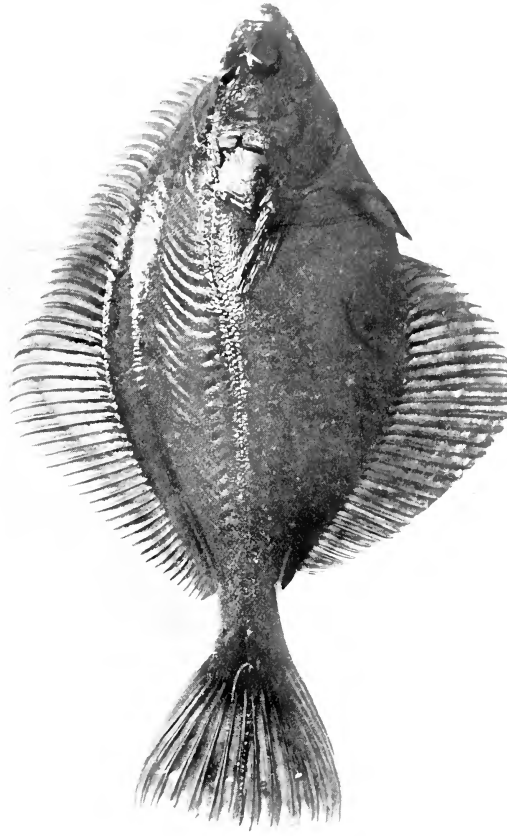


Fig. 267.—The Flounder.

these open or close to make the back the same colour as the ground on which the fish is resting. This changing of colour continues for a time after the fish is dead, and may be seen by removing the fish from a

light-coloured place to a dark. This provision of nature prevents its being detected by enemies, and, no doubt, saves its life on many occasions.

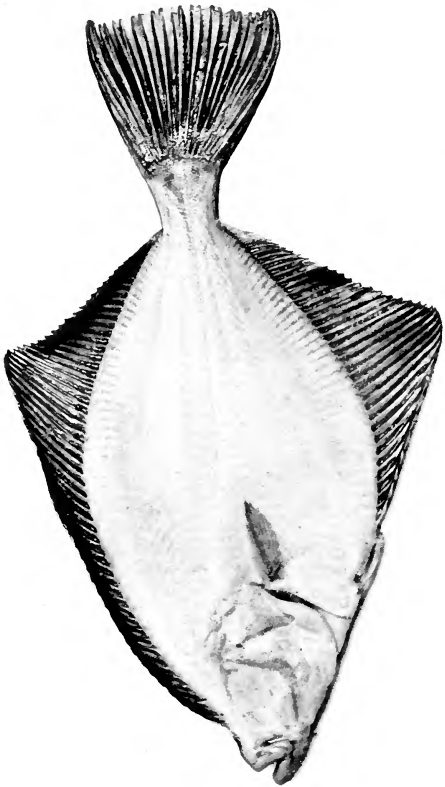


FIG. 268.—The Flounder, underside.

The fins of the flounder are also peculiar. The dorsal fin extends from head to tail on the left side, and increases in breadth to the middle, and tapers down again to the tail. It has fifty-five rays. The

anal fin, which commences below the ventral fin, is also broader at the centre of the body, and has thirty-eight rays. The pectoral fin has nine rays on the upper and nine on the under side. The ventral fin has six, and the caudal fifteen rays. In rivers flounders are seldom caught over 1½ lbs. In Loch Speggie in Shetland I have caught them over 2 lbs., while in the sea they grow to a larger size. They are quite good for the table. Occasionally flounders are found with their eyes and belly on the left side instead of the right.

ALLIS SHAD

(*Clupea alosa*)

THE allis shad is found in a number of rivers during the spawning season, which occurs in June and July. This fish is not so well known in Scotland as it is in England. A fair number are caught by the nets on the Tay, and those I have examined have invariably been filled with spawn. The average weight of those that have come under my notice was about 5 lbs. It is a short thick fish about 20 inches in length. The dorsal fin, consisting of sixteen rays, is very small for the size of such a fish, and the tail is very much forked. The tail has twenty-five rays, pectoral fin fourteen, ventral fourteen, and the dorsal eight.

Characteristic of this fish is the colouring. The back is of a light slate colour merging into a bright silver on the sides and becoming quite white on the belly. The latter is covered with strong scales, which run along the under part from head to tail in a well-defined ridge. Between the ventral fin and the tail are fourteen strong spines, which no doubt is the principal weapon of defence. The mouth and head are very large and broad, whilst the eyes have a large black centre surrounded by a golden colour on the outer edge. On opening the mouth one is struck with the beautiful way the gills are arranged. From the latter numerous branches point outwards almost to the exterior, and are arranged in sets. The first set is quite $1\frac{1}{2}$ inches long, consisting of 120 branches closely set together. Following this again comes the second set, which are shorter, diminishing to about an eighth of an inch into the throat, where the upper and lower sets

FIG. 269.—Allis Shad.

come close together, forming a complete sieve. If reference be made to the illustration one has a better idea of this beautiful construction (Fig. 270).

There is yet another shad, known as the twait shad, which can be identified from the allis shad by its having six to eight spots on its sides, whilst the former has only one behind the gills. In addition to the shads, the smelt and sturgeon invade our fresh waters.

FIG. 270.—Mouth of Shad.

THE LOACH

(*Nemachilus barbatulus*)

THE loach is common to the rivers of the United Kingdom, inhabiting those of a slow-running nature. They invariably seek shelter

FIG. 271.—The Loach.

under some flat stone, only to fall a prey at the hands of some youth expert in the art of "guddling." It is said to be good eating, but I have never known it to be eaten by Scotch people. Loach take worm freely, but are of no sporting value, as they are so small, being on an average from 3 to at most 5 inches in length. The colour is usually olive with dark blotches; the tail and dorsal fins are mottled much like the markings on a feather. In Ireland they are frequently used as a spinning bait for salmon and trout, as they are much tougher and stand more knocking about than the much-used minnow.

THE LAMPREY

(*Petromyzon marinus*)

In May and June the lamprey ascends our rivers to spawn. A number of these are frequently caught in the salmon fishers' nets

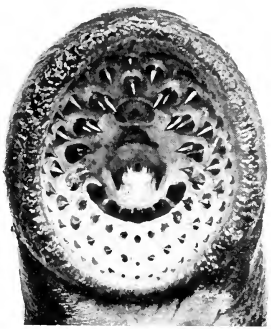


Fig. 272.—Mouth of a Lamprey, showing the sucker and teeth. Half life size.

on the Tay, and are mostly from 24 to 30 inches in length, and weigh from 2 to 3 lbs. They are more plentiful in England than in Scotland, and are caught for the market. The colour is bluish-green with brown blotches, merging into an orange colour on the belly.

The lamprey has a very characteristic mouth. When opened to its fullest extent it is quite round and has the tongue well armed with numerous teeth (see Fig. 272, which gives a very clear representa-

FIG. 273.—3-lb. Lamprey, 30 inches long, caught in the Tay. July 1909.

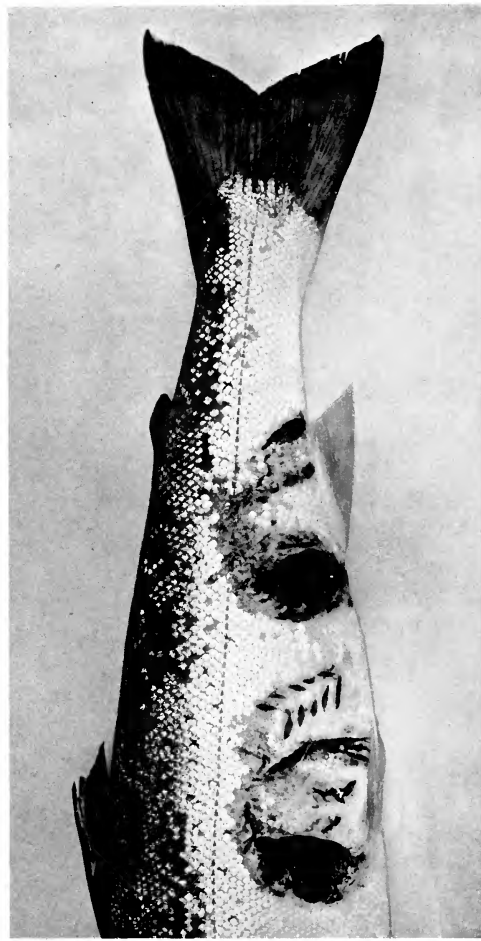


FIG. 274.—Sea-trout marked by Lamprey.

tion of this formidable mouth). The outer part of the mouth is encircled by a strong band of skin, and the whole forms a most perfect sucker, by means of which the lamprey attaches itself to some stone or fish. If the latter, then it runs a great risk of losing its life. The lamprey once fixed to its prey, begins its deadly quest; the outer strong edge remains stationary, whilst the teeth commence to move and cut up the flesh, and ultimately gouge out a deep hole in its victim. The salmon appears to be a favourite with the lamprey, judging by the number that have come under my notice marked in this fashion. Fig. 274 shows a sea-trout marked by a lamprey. Occasionally they are brought ashore by the nets, firmly fixed to a salmon, and only desist when they see they run the risk of being caught. I feel sure that many salmon are killed by the wounds inflicted by this gnawing creature.

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